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THE EAR

AND ITS DISEASES

BEING

PRACTICAL CONTRIBUTIONS TO THE STUDY OF

OTOLOGY

BY

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WITH NUMEROUS ORIGINAL ILLUSTRATIONS

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PREFACE.

THE Author has not attempted to present to the profession a treatise on the ear embracing the entire field of otology, but he trusts that the particular subjects embraced in the work, and to which he has directed more special attention, may be found of service to those interested, whilst not devoid of interest to the otologist. To the Author's early acquired vogue of noting in detail matters of practical interest in private and hospital practice is due the accumulation of the records of some ten thousand aural cases, or about one-third of all such that have passed through his hands during the past twenty years. It is at the earnest request of his professional friends, and many of the practitioners and students who have attended his aural clinics at the New York Eye and Ear Infirmary, and formerly at the New York Ear Dispensary, that he has been induced to select from this and from his published writings, the material of which this work is composed.

The labor of co-ordinating the immense accumulation of clinical material would scarcely have been undertaken but for such encouragement, and the valuable aid of his assistants in hospital work. To the latter, namely, Drs. Wm. A. Bartlett, Robert Barclay, and C. J. Colles, his sincere thanks are extended for faithful work on his clinical records at the Infirmary, and their assistance in preparing a card index to all of his records, comprising some forty thousand reference cards, and the revision and classification of the same, and for many original drawings and diagrams to illustrate the text.

The Author has abstracted considerable matter in the prepara-

tion of the work from his more practical contributions to the medical journals of the day, both home and foreign, during the past fifteen years, omitting much that has in the mean time become obsolete.

In studying the functions and diseases of the ear, it has been endeavored to avoid the too exclusive consideration of local conditions, with a view to separate treatment apart from the whole, since otology in its broadest sense should embrace a consideration of the upper air tract, of which the middle ear forms but a part, and of regions contiguous to the ear.

Both the anatomy and physiology of the ear embrace a literature too extensive to be more than briefly considered in the scope of this work, the essential anatomy and physiology of the organ only, therefore, have been for the most part introduced along with the text, where, it is believed, they will best serve the purposes of the reader.

The writer has not always employed the term "chronic catarrh" in speaking of the morbid processes of the mucous membrane usually known by that name, believing that it does not in every case fully describe the conditions present.

The following subjects introduced in the work are considered as worthy of special mention here, inasmuch as they present features not usually made so prominent in works on the ear: Catarrh of the upper air tract; Oral irritation, specially dentition and diseased teeth, and Sea bathing—their causative influences on the ear. Wounds and injuries of the ear, occurring in warfare and civil life. Rupture of the drum-head from boxing the ears, and its medico-legal aspect. Concussion from the blast of great guns and explosives, etc. Anomalies of audition, noises in the ears and their connection with insane hallucinations and delusions. [It is hoped that in thus drawing attention to some unfortunate persons who have symptoms of mental aberration wholly due to "noises in the head" (ear!), a more satisfactory plan in their treatment may be adopted.] The effects of false hearing on singers, actors, lecturers, and musicians are also considered in this connection. Other-

matoma occurring among lunatics, pugilists, and others has been presented very fully, and will, it is believed, be of special interest to alienists and examiners in lunacy.

The operation of excision of the drum-head and ossicles for otorrhœa, and deafness due to chronic catarrh of the middle ear, including a full account of the literature of the subject. The results of this operation have been satisfactory, and it is hoped that its usefulness will be confirmed by experience.

The classification and education of school children with defective hearing.

The effect of high atmospheric pressure on the ear in tunnels, caissons, and in diving. The increase of submarine labor of late years makes it very important that the effect of such work on the ear be understood.

The subject of pension claims of soldiers, sailors and marines on account of disability from deafness is discussed.

The Writer has been greatly assisted in the collecting of facts relating to the effects of casualties of warfare on the ear by officers of the army and navy, and he trusts that they may continue to favor him with any observations bearing on this subject coming to their knowledge. The admirable instruments, of which cuts are given, which have been employed in the Author's practice, were made by Mr. W. F. Ford, the well-known instrument-maker.

Much of the work of abstracting the writer's papers, translations, etc., revising the proof sheets, and the entire preparation of the index has been done by Dr. Colles, whose name appears as editor on the title page of the book.

SAMUEL SEXTON.

12 West 35th Street,
New York, September, 1888.

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PART FIRST.

REMARKS ON THE ANATOMY AND PHYSIOLOGY OF THE AURICLE, EXTERNAL AUDITORY CANAL AND CONTIGUOUS PARTS, AND THE MEMBRANA TYMPANI.

CHAPTER I.

The auricle. The external auditory canal. The attachment of the auricle and cartilaginous canal to the temporal bone. The auriculo-cranial muscles. Relations of the temporo-maxillary articulation to the cartilaginous portion of the external auditory canal. Further remarks on the exterior muscles and fascia of the ear. Observations on the comparative physiology of the auricle. The functional movements of the auricle. The voluntary movements of the auricle in man.

THE AURICLE.

The cartilaginous expansion at the outer terminus of the ear constitutes the *auricle and outer portion of the external auditory canal.* The functions and diseases of these parts are similar and will, therefore, be considered somewhat in connection with each other.



FIG. 1.—THE AURICLE (FROM BURNETT).

a, Helix; *c*, antihelix; *b*, fossa of the helix; *d*, fossa of the antihelix; *e*, tragus; *f*, antitragus; *h*, lobule; *g*, concha.

The pinna, or wing of the ear, as the auricle is sometimes called, is topographically entirely unlike any other region of the body, consisting as it does of a delicate but firm cartilaginous framework which is

much exposed because of its prominently outstanding position. This pavilion varies in size and shape in different individuals; in general contour it is hollowed out like a shell; the concha proper, the deepest part, is the expansion with which the external auditory canal commences. The auricle is twenty-three to thirty lines in length, thirteen to twenty-eight in its greatest width, and from one-half to two or three lines in thickness.

It stands out from the skull at an angle of from 30° to 40°, the angle being more acute forward and above than behind. It rarely happens that this angle is less than 10° or greater than 45°. The form of the auricle is very irregular in consequence of the foldings of its cartilage. It is well adapted to the collection of sound and from its general outspreading shape aids in affording tension to the transmitting apparatus of the drum. It is sufficiently movable in its attachment, and pliable, to be safely pressed against the head when lain upon.

The irregularities of the auricle's surface, due to foldings of the cartilage, while presenting a pretty uniform appearance to casual inspection, are on closer observation found to be differently moulded in almost every subject. So characteristically distinct is this variation that for personal identification a photograph of the organ would often serve a better purpose than one of the face, since the former is less subject to the mutations of time or other changes to which the latter is liable.

Significance of the auricle's configuration. Without doubt the large auricle is more serviceable acoustically, its ample receiving surface favoring the collection of sound (and probably also the appreciation of its source); but most persons would willingly exchange any advantage of this kind for the possession of a small and shapely organ which is considered an evidence of aristocratic ancestry. The size and shape of the auricle, however, usually depends on the general configuration of the individual, and, consequently, some individuals of every race or social station have small and handsomely formed ears. The ear in negroes is an exception to the above in this, that the organ is smaller than in other races.

Both ancient and modern writers have attached much significance to the size and figure of the auricle and its angle of attachment to the head; thus idiots and imbeciles are said to often have peculiar ears, a statement not warranted by the facts—congenital defects of the organ by no means being always or indeed common among them. The observations of physiognomists in regard to the significance of the ears in determining character, do not hold true beyond the fact

that they maintain a very constant configuration in individuals of similar physical development, irrespective of race.

Charles Darwin, in his untiring search for evidence of man's evolution, discovered a morphological correspondence between man and monkey, namely, the frequent occurrence of an irregularity in the cartilage forming the superior border of the helix of man's ear corresponding with the more unvarying pointed ear in some species of monkeys.

The acoustic value of the auricle is not accurately known, although it has been the subject of much discussion. Military surgeons and other authorities have asserted that, where the organ has been entirely removed by wounds or by design, no loss of hearing occurs. It is probable, however, that in the cases observed, the hearing power was not accurately tested either before or after the injury. The absence of auricles must entail some defectiveness in hearing, especially in respect to orientation, since those who have been deprived of the organ frequently use the palm of the hand as a substitute.

The auricle and external auditory canal constitute a non-resonant natural trumpet, whose smooth and generally concave surface condenses sound-vibrations approaching the drum-head ; even the folds of the auricles are believed to reflect and thus intensify sound in its passage to the concha.

The Helix, incurving, affords a border to almost the entire circumference of the auricle. On its outer face the helix begins in the bottom of the concha, dividing it into two unequal portions, the lower one being larger than the upper. This horizontal portion of the helix is called its *spine;* it presents a short pointed prolongation on reaching the anterior edge of the auricle, and from thence it (the *crus*) curves upwards, forming the anterior border of the auricle ; the helix then circles around the summit of the auricle to terminate behind and below in the *cauda helicis.*[1]

The Antihelix is a fold of cartilage situated within the helix, commencing just above the antitragus, passing upwards and describing a semicircle, the convexity of which corresponds with the concavity of the helix. It terminates anteriorly by two diverging branches, the space between which forms the *fossa of the antihelix.* The space between the helix and antihelix is the *fossa of the helix.*

The Tragus is called thus from supporting a bunch of hair more or less prominent in persons of advanced years.

The Antitragus lies opposite the tragus and behind the meatus.

[1] In mammifera it constitutes a separate cartilage, the *scutulum.* Huschke. Splanchnologie, Paris, 1845, p. 749.

The cartilage of the antitragus is much smaller than that of the tragus.

The Concha is the largest of all the fossæ of the external ear, being bounded behind by the antihelix, and below continuous with the external auditory meatus.

The inner face of the auricle possesses many irregularities which correspond with those of its outer face. The most prominent elevation, the convexity of the concha, affords attachment for the abductor muscle of the ear. The greater portion of the concha is applied to the side of the head, the posterior superior portion only being free.

The Lobe is a cutaneous cushion, flaccid and without cartilage, its free border extending from the tail of the helix behind to the skin covering the articulation of the lower jaw. Its size is determined in different individuals by its dependence and the varying amount of fat in its connective tissue.

The Cartilage of the auricle is soft, spongy, and elastic, its cartilaginous cells, according to Huschke and others, lying in a retiform tissue. Huschke found, on maceration and removal of its perichondrium, that it was very brittle, so that the thin edge of the helix could be with difficulty obtained intact; he states also that there is little tendency to ossification in the progress of age. *The perichondrium* is firmly adherent to the cartilage. The skin enveloping the ear is separated from the perichondrium by a thin layer of connective tissue; it is continuous with the lining of the external auditory canal. Its attachment to the cartilage throughout permits of a slight movement, but the covering of the lobule moves much more freely. The skin is freely supplied with sebaceous glands which become larger in size and more numerous in approaching the external auditory meatus. The secretion of these glands increases in the same proportion, assuming finally, deeper in, chemically, the character proper to the glands of this region.

Hairs are most abundant on the outer face of the auricle; they are especially numerous and stiff on the tragus of the male. Varying in length from an inch to an inch and a half, they curl irregularly, turning sometimes into the external auditory canal.

Muscles of the auricle. With the exception of the helicis major these muscles do not seem to exert any influence upon the tension of the transmitting mechanism. On the outer face of the concha are the *helicis major and minor muscles;* the former is interwoven at its broad upper end with the superior auricular muscle, and attached loosely at its small end to the outer edge of the helix and spine of the latter. The helicis minor aids the above.

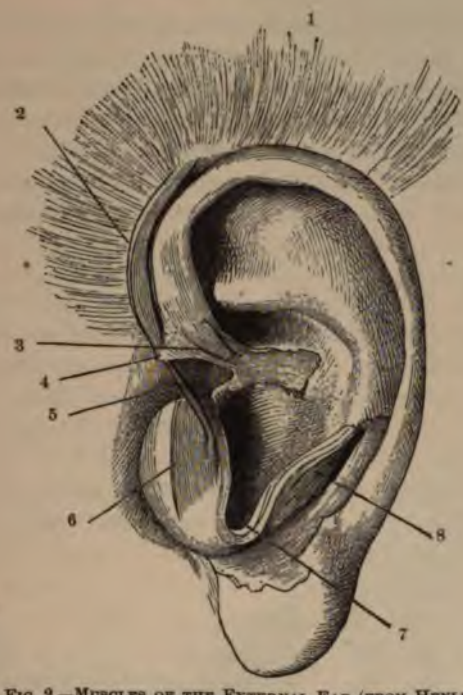


FIG. 2.—MUSCLES OF THE EXTERNAL EAR (FROM HENLE).

1, Auricularis superior; 2, helicis major; 3, helicis minor; 4, spina helicis; 5, fibres of the tragicus muscles sometimes attached to the spine of the helix; 6, tragicus; 7, incisura auris; 8, antitragicus.

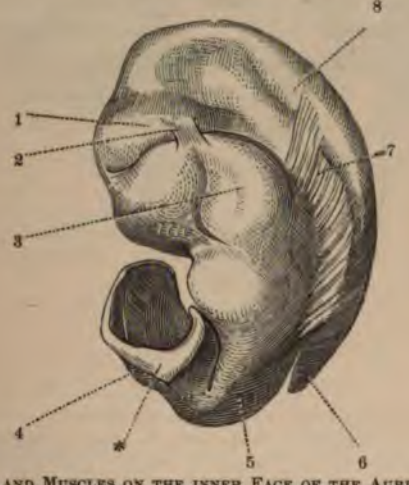


FIG. 3.—CARTILAGE AND MUSCLES ON THE INNER FACE OF THE AURICLE (FROM HENLE).

1, Eminence made by the triangular fossa; 2, obliquus auriculæ; 3, eminence made by the fossa of the concha; 4, cartilage of the external auditory canal; *, its surface of attachment to the edge of the bony canal; 5, cartilage of the pinna; 6, cauda helicis; 7, transversus auriculæ; 8, eminence made by the scaphoid fossa.

The *antitragicus muscle* sends fibres to the upper edge of the posterior surface of the posterior wall of the cartilaginous canal (Henle); some of its fibres are inserted into the processus caudatus of the helix. The *tragicus muscle* is short and lies on the outer surface of the tragus; its flattened fibres take a vertical direction.

On the inner face of the auricle are the *obliquus* and *transversus auriculæ muscles*. Like the tragicus, these muscles are in man quite insignificant.

THE EXTERNAL AUDITORY CANAL.

The external auditory canal extends from the bottom of the concha to the membrana tympani, and consists of an outer, cartilaginous portion, and an inner, bony portion, the latter being the longer. The size of the canal varies much, its length, according to Huschke, in adults being from ten to seventeen lines, its height four to six lines, its width three lines. The length of the inferior wall of the osseous portion is much increased by the inclination of the membrana tympani.

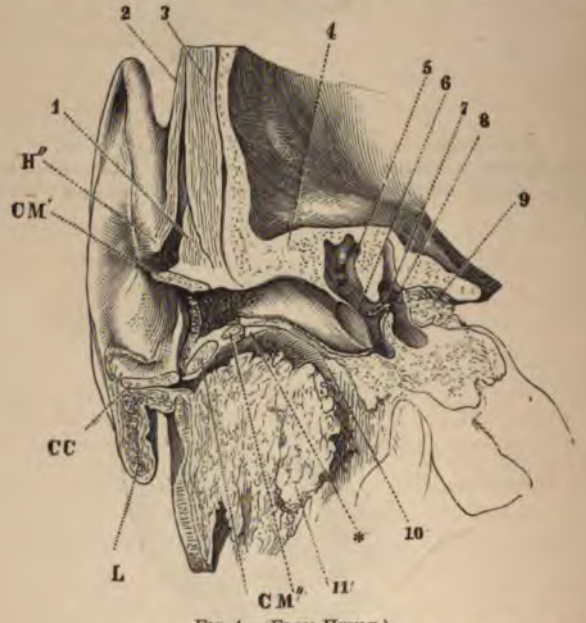


FIG. 4.—(FROM HENLE.)

Section through the External Auditory Canal at the junction of the Cartilage of the Auricle, CC, with that of the External Auditory Canal, from the upper wall of which a small strip, CM', remains; CM'', inferior wall of the cartilage of the canal; H'', spina helicis; L, lobe of the ear; 1, M. epicranius temporalis; 2, M. auricularis superior; 3, M. temporalis; 4, superior wall of the bony canal; 5, cavity of the tympanum; 6, membrana tympani; 7, stapes; 8, vestibule; 9, meatus auditorius internus and acoustic nerve; 10, inferior wall of the bony canal; 11, parotid gland; *, fibrous lip of the border of the bony canal

The Cartilaginous Portion. In direction, this portion of the canal, from without inwards, passes forwards and upwards, and is somewhat twisted upon itself; owing to these inflections, an inspection of the drum-head cannot always be made without straightening the canal by lifting up the auricle. At the commencement it is largest anteriorly, being composed of a large and irregular quadrilateral plate of cartilage, with rounded angles, forming first the tragus in front of the orifice, and then sweeping inwards to form the anterior and lower wall of the canal. The plate is turned up upon itself, and lies close to the posterior face of the concha. It may be felt during dissection by pressing the forefinger between the back of the concha and the mastoid process.

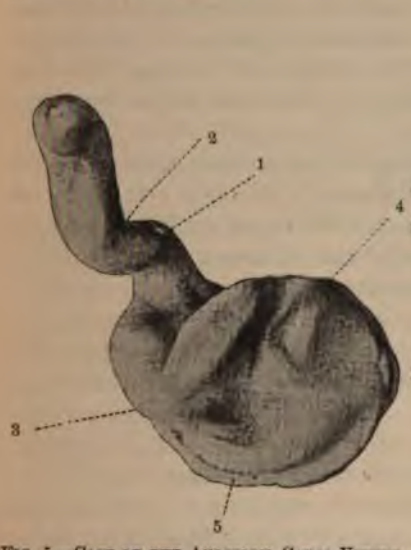


FIG. 5.—CAST OF THE AUDITORY CANAL VIEWED FROM ABOVE (FROM BEZOLD[1]).

1 and 2, First and Second Curvatures of the canal; 3, S-shaped Curvature of the concha; 4, fossa intercruralis; 5, fossa scaphoidea.

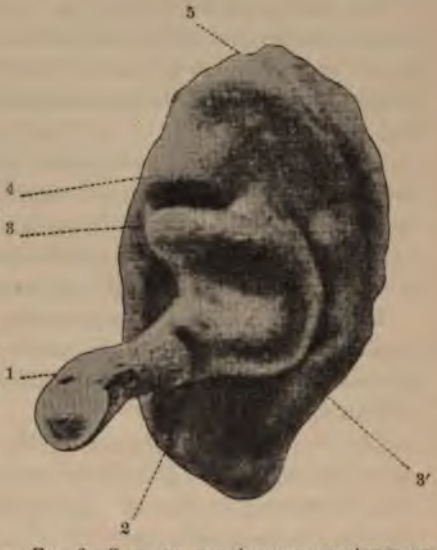


FIG. 6.—CAST OF THE AURICLE AND AUDITORY CANAL VIEWED FROM WITHIN; FACE OF DRUM-HEAD; CANAL FORESHORTENED (FROM BEZOLD).

1, Drum-head; 2, second curvature of the canal; 3, upper, 3′, lower part of the concha; 4, fossa intercruralis; 5, fossa scaphoidea.

The inner surface of this plate is attached to the rough margin of the auditory process of the tympanic plate which forms the inferior anterior border of the bony meatus. The posterior superior wall of the canal is formed by that portion of the cartilage which is folded back upon itself from the anterior edge of the concha, and by mem-

[1] Die Corrosions-Anatomie des Ohres. Friedrich Bezold. München, 1882.

branous tissue which serves to complete the closure of the anterior inferior cartilaginous canal; it extends backwards about three-quarters of an inch to be firmly attached to that portion of the rough surface of the auditory plate forming the posterior superior border of the osseous meatus.

Pressure in front of the tragus usually closes the lumen. In advancing years, and always in some subjects, the posterior edge of the meatus impinges upon the lumen, and, in thus closing the outlet, sometimes prevents the natural escape of cerumen. Owing to this valve-like arrangement, however, the entrance of foreign bodies is difficult. In children, where the meatus is often less obstructed in this manner, objects are more easily introduced.

The more striking topographical features of the cartilaginous canal are a considerable hollow in the membranous upper part, and the fissures forming interruptions on its sides completely dividing the cartilage into three half rings, resembling the divisions in the cartilage of the trachea.

Between each couple of rings is found a fissure or so-called *incisura Santorini*, closed by fibrous elastic tissue. The *exterior fissure* is three or four lines distant from the edge of the tragus; it commences at a narrow part on the anterior face of the cartilage, and terminates on the superior face, being here from one-half to one line in width.

The *interior fissure* occupies the inferior face, extending itself a little on the posterior; it is one to one and one-half lines from the preceding and larger at its middle. In rare cases there may be a third smaller fissure.

The M. incisuræ Santorini, M. intertragicus (Jung), or *dilator muscle of the concha* (Theile), is placed above the larger fissure. It lies, according to Henle,[1] inferiorly and medianly to the tragicus muscle, on the anterior surface of the anterior wall of the cartilaginous canal, and passes over the lateral incision of the cartilage. The last-named author says that Theile found this muscle very distinct in a case in which the tragicus muscle was present in a very rudimentary state only.

A branch of the stylo-glossus muscle is sometimes connected with the cartilage of the canal. Henle,[2] in describing this muscle, says its auricular head (*Caput auriculare M. styloglossi* Gruber) is sometimes found as an independent muscle, the *stylo-auricularis* of Hyrtl or *M. depressor auriculæ* of Lauth. The muscle just mentioned was dis-

[1] Lehrbuch der systematischen Anatomie des Menschen, 1873, vol. 2, p. 759.

[2] Anatomie, vol. 2, p. 104.

covered by Hyrtl, and is, according to Huschke,[1] met with one time in six; it is fusiform, and from one-half to one and one-half lines in thickness. Both these muscles appear to be able to enlarge and stretch the external auditory canal.

The platysma myoides or *M. subcutaneous colli* sends also occasionally some lateral fibres to the under surface of the cartilage of the canal, according to Cowper.

The skin lining the canal gradually becomes softer, redder, and more vascular and sensitive, more secretory, very much resembling a mucous membrane as it covers the drum-head. It may be detached more easily from the canal than from the concha, and at the outer extremity it is smoother. Its layers grow thinner in the same proportion; the papillary tissue disappearing, there remains at the membrana tympani scarcely more than soft and thin epidermis, according to Huschke.

The hairs of the canal are shorter and finer than those on the tragus. Usually they are not observed before the age of puberty, and in some individuals are much more abundant than in others. In the bony portion of the canal they become less numerous and of shorter length, and we do not find them at all at the inner end. In disordered states of the meatus these hairs fall out in great numbers. Combining with the increased sebaceous secretion usually present, they may constitute a part of ceruminous collections.

There are both sebaceous and ceruminous glands in the external auditory canal. The *ceruminous glands* are found in greatest numbers at the junction of the cartilaginous and bony parts, where they may number twenty to thirty to the square line; the whole number has been estimated at one or two thousand. These glands resemble somewhat in their structure the sudorific glands. They begin with short and somewhat straight excretory ducts of one-twentieth to one-fortieth of a line in diameter, the glands themselves being ovoidal in shape and one-quarter to one-half a line in depth. They are lodged in a rhomboidal utricle of tendinous tissue. The unequal aspect of the glands depends on the turns of the utricle into which the tendinous tissue is rolled. Each gland terminates in a dilated extremity, and is lined with epithelial scales.

[1] Splanchnologie, p. 756.

THE ATTACHMENT OF THE AURICLE AND CARTILAGINOUS CANAL TO THE TEMPORAL BONE.

The cartilaginous framework of the ear is so attached to the temporal bone as to admit of very free movement, the tubular portion, known as the cartilaginous canal, being loosely telescoped, so to speak, into the beveled outer surface of the osseous meatus, and, though firmly united to the posterior superior curved surface of the auditory plate (which rounds off the angle formed by the junction of the posterior root of the zygoma with the mastoidea, affording a long, narrow, projecting, and roughened articular surface), and also to the auditory process of the tympanic plate, it has a free, gliding motion in the surrounding tissues.

The membranous portion, which has been described as closing a large defect in the cartilage composing the canal, and which increases its mobility, is attached anteriorly and inferiorly along with the cartilage to that portion of the roughened margin of the osseous meatus formed by the auditory process of the tympanic plate. These two osseous margins, affording attachment for the cartilaginous canal, run from anteriorly and above downwards and convergingly, to form the ovoidal opening which constitutes the osseous meatus auditorius externus. *A smooth gap is left between the beginning of these rough margins which extends all the way down along the anterior wall of the osseous meatus to the smooth outer surface of the auditory plate; over this even plane glides a continuation of the temporal fascia,* the significance of which will be considered in another connection (see page 22).

The common integument forming the outer covering of the auricle aids somewhat in attaching the exterior parts to the deeper ones, but the superficial and deep layers of the temporal fascia and the skin muscles are the principal means.

Anteriorly both layers of fascia give off fibrous bands which are attached to and blend with the outer face of the cartilage of the auricle. 1. From the superficial layer to the anterior superior border; these extend themselves to the posterior edge of the fossa of the helix. 2. A yet stronger band from the deep temporal fascia to the spine of the helix. 3. A strong band from the deep fascia is attached to the tragus—a superficial portion blending with the cartilage, and a deep portion extending along the cartilaginous canal to its attachment to the margin of the osseous meatus, which deep connection is also influenced by the action of the superficial fascia.

Posteriorly, from the deep fascia a band is attached to the inner face (convexity) of the concha just above the insertion of the scanty fibres of the posterior (retrahens) muscle; another band passes forward from the deep fascia about the anterior border of the mastoidea to be attached a little below the former.

The auricle, on the whole, is thus attached rather loosely to the temporal bone. The anterior portion of the inner face of the concha is fixed to the roughened surface of the mastoidea by the fascia and connective tissue, but its posterior portion is free and can be felt in its place over the mastoid process.

The deep cranial aponeurosis, which is thinner over the temporal region than elsewhere, lies beneath the superior and anterior auricular and the superficial temporal muscles, being connected to them by very dense cellular tissue. It seems to bind all the tensor muscles, thus giving support to their action. When acted on it glides freely over the deep temporal muscle. It sends fibres over to the auricle on a level with the tendon of the superior auricular muscle, after crossing which they are attached, along with the extrinsic ligaments of the auricle, to the convexity of the concha.

The superficial temporal fascia sends fibres of attachment to the anterior surface of the tragus and to the spine of the helix. The deep fascia, blending in front of the tragus with the fibres of the above, forms a strong band which is attached along the outer surface of the cartilage of the canal as far as its insertion into the osseous meatus. This strong band lies on the smooth shallow groove formed upon that portion of the squamosa lying between the tympanic and auditory plates above mentioned. In viewing the osseous canal in the prepared specimen it will be seen that its roof, formed by the auditory plate, extends outwardly much further than the floor and sides, which are formed by the tympanic plate and extend inwardly (Leidy).

THE AURICULO-CRANIAL MUSCLES.

The *Musculus epicranius* is considered by Henle under five divisions:

M. Epicr. frontalis.
M. Epicr. temporalis (auricularis anterior).
M. (Epicr.) auricularis superior.
M. (Epicr.) auricularis posterior.
M. Epicr. occipitalis.

These small thin muscles are known as the skin muscles of the

scalp, and from them such motion as the auricle in man possesses is derived. This may once have been greater than now, but so far as the needs of man are concerned they are relatively as important as those in some of the lower animals where they still possess a wide range of action, as may be seen in the dog, horse, or cat. Their apparent deterioration may be due to disuse. So little attention has been given to their relations to the movements of the ear, and remotely

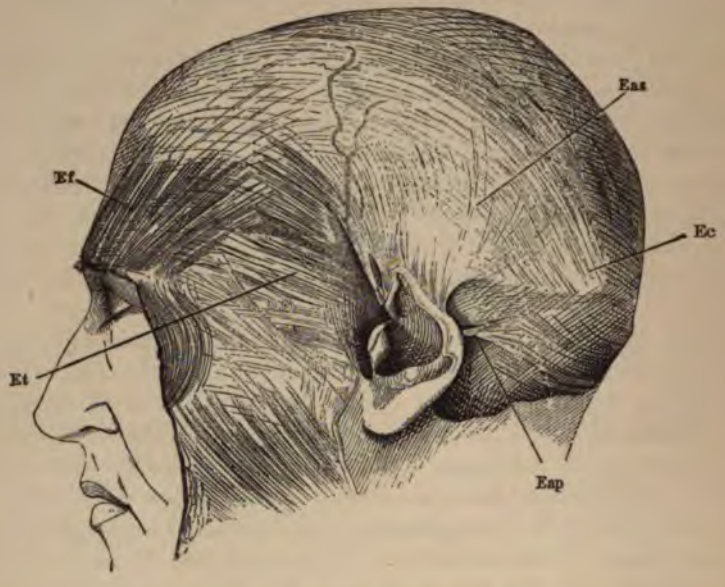


FIG. 7.—MUSCLES OF THE CRANIUM (FROM HENLE).

to the tension of the transmitting apparatus, that they seem entitled to a more extensive description in a work on otology.

Three of these muscles are attached directly to the auricle: (1) the anterior or M. epicranius temporalis; (2) the superior; (3) the posterior auricularis. Sappey describes a fourth, the superficial temporal, which is, however, so small that its existence has been doubted. It takes its origin from the temporal fascia and is attached by two fibrous bundles, of which the superior blends with the occipito-frontalis, the inferior with the anterior auricularis.

The *anterior auricular* s. *attrahens auriculæ* (or, as Henle calls it, the *M. Epicranius temporalis*), situated on the lowest part of the temple in front of the auricle, is very small, extremely thin, and quadrilateral in form. It is inserted at its auricular extremity into

the projecting spine of the helix and the corresponding part of the anterior edge of the concha. From this double origin it passes forward and slightly upward and is inserted, like the preceding, upon the cranial fascia. Sappey says the greater number of anatomists since Winslow have erroneously stated that this muscle has a fixed insertion to the zygomatic arch; he himself has always found it separated from the latter by about one centimetre and forming an



FIG. 8.—MUSCLES OF THE HEAD (FROM SAPPEY).

1, Posterior auricular muscle, composed of two bundles; the superior short, the inferior longer; 2, superior auricular muscle; 3, anterior auricular muscle; 4, occipital muscle; 5, section of the fascia which extends from the external third of the occipital muscle to the superior occipital muscle; 6, fascia starting from same external third of occipital muscle which passes under the deep face of the superior auricular muscle; 7, superior fibres of superficial temporal muscle, situated upon the prolongation of the two layers arising from the occipital muscle; 8, inferior fibres of same united to the anterior auricular by the intermediation of a fibrous layer which forms a part of the epicranial fascia.

acute angle with it. The length of the little muscle is not more than twelve to fourteen millimetres, and its width is about one centimetre. It lies beneath the superficial temporal vessels and the skin, and on a plane deeper than that of the superior auricular. Immediately be-

neath it is the cranial fascia, which terminates on the limits of the anterior auricular, blending with the aponeurosis of the crotophite (temporal) muscle. Its lower edge runs along the anterior ligament of the auricle which covers it somewhat. Its superior edge is continued in part with the corresponding edge of the M. elevator. The use of this muscle is to draw the auricle upwards and forwards. It assists, furthermore, in making the fascia tense (Sappey).

According to Henle, the anterior auricular muscle, or musc. epicr. temporalis, *i. e.*, the anterior, narrow, and thin strip of the lateral portion of the epicranius muscle, takes its tendinous origin beneath the root of the zygomatic arch on the margin of the bony canal. It is also connected with the cartilaginous canal, with the capsule of the temporo-maxillary articulation, and with a tendon under which the temporal vessels pass. The muscular fibres run parallel upwards and forwards, some reaching the edge of the epicranius frontalis and the orbicularis oculi.

The *superior auricular* (or *attolens auriculæ*) is the most important of the three muscles attached to the auricle, as regards size. It is situated immediately above the auricle on the hinder part of the temple; it is vertical, broad, and thin, triangular in form, the truncated summit presenting downwards to be inserted on the convexity of the anti-helix, and also on the corresponding part of the helix, by the aid of a fibrous lamella of a gray color.

This muscle is covered externally by a very thin aponeurotic layer and by the skin. It lies internally throughout on the cranial aponeurosis, which envelops the entire posterior surface of the auricle, and is lost in the superior attachment of the muscle. Its posterior border, ascending vertically, runs along the superior border of the occipital muscle; the anterior border corresponds inferiorly to the anterior auricular muscle with which it continues in part, and superiorly to the superficial temporal muscle from which a fibrous interception separates it.

The uses of this muscle are to elevate the auricle and to dilate the external auditory meatus. Its action also aids in making tense the cranial aponeurosis.

The *posterior auricular* (or *retrahens auriculæ*) is formed usually of two small bundles of muscular fibres, the superior and the inferior; rarely they are united, and more rarely still is one of them divided into two. These bundles extend horizontally from the auricle to the mastoid process, the lower one extending sometimes even to the occipital muscle; they are attached to the convexity of the concha, pass parallel to each other, backwards and slightly upwards, to be

inserted, the superior to the mastoid process, the lower sometimes to the same place, but more often to the aponeurosis at the insertion of the sterno-mastoid muscle. This second bundle presents frequent varieties; sometimes it is short and attached immediately under the foregoing; in other instances it is longer, Sappey having seen it prolonged even to the tendon of the trapezius, and consisting of two distinct bundles united by a large fibrous intersection, one of which connected with its origin, the other with its termination. The strength of these tendons indicates the very considerable potency of this muscle. Superficially, this muscle is closely connected with the skin by means of the connective tissue, which increases in thickness as it approaches its occipital termination. Its action is to draw the auricle backwards and dilate the external auditory meatus.

The above-mentioned muscles are in some of their actions aided considerably by the *occipito-frontalis muscle*. This latter really consists of four muscles, two on each side; the two of the same side correspond—one of them, the occipital, to the posterior part of the cranium, the other, the frontal, to its anterior part. Being united by the cranial aponeurosis, they have been considered as a digastric muscle, to which has been given the name of occipito-frontalis.

The *occipital muscle* (*epicranius occipitalis*) blends with the mastoideus and trapezius muscles (see cut). From its external third starts a fibrous band which divides itself on a level with the superior auricular muscle into two layers, one of which covers the cutaneous face of this muscle, while the other passes beneath it and towards the superficial temporal muscle. The anterior edge of the muscle is almost horizontal, and presents to the mastoid portion of the temporal bone and to the tendon of the superior auricular muscle. Its upper edge corresponds to the posterior edge of the superior auricular, so that the fibres of the two muscles are both perpendicular.

The principal use of this muscle is to draw the cranial aponeurosis downward and backward and thus assist the action of the frontalis, since the one muscle affords the fulcrum on which the other acts.

The frontal muscles have been considered by a large number of authors as forming a single muscle, but clinical observation and electro-physiological experiments establish clearly that they are independent. The frontalis arises from the anterior part of the facial aponeurosis by two origins a little in front of the frontal-parietal suture, and descends—the internal fibres passing vertically, the others obliquely—to be inserted along with the orbicular into the skin of the eyebrows.

The writer has seen instances where the occipital and temporal

muscles, acting independently of each other, exerted an influence on the fascia in such a manner as to very much assist the aural muscles in moving the ear.

For the anatomical description of these muscles and the neighboring fascia, the writer, besides his own limited dissections, is indebted to the works of other writers, notably those of Henle and Sappey.

Further research in the comparative anatomy of this subject is much needed, since from this source alone can many disputed and obscure points in the functions of the ear be settled.

RELATIONS OF THE TEMPORO-MAXILLARY ARTICULATION TO THE CARTILAGINOUS PORTION OF THE EXTERNAL AUDITORY CANAL.

The parietes of the cartilaginous portion of the external auditory canal are compressed from before backwards by the condyle of the lower jaw in front. The movement of the condyle against the anterior face of the yielding canal may be felt on placing the finger in the concha during mastication; it brings the anterior wall of the canal into varying relations with the mastoidea, against which the posterior wall lies separated only by connective tissue and fat.

Whilst admitting of this encroachment of the condyle, it also readily partakes of the free movements of the auricle.

The canal glides freely up and down the space between the ramus of the jaw and mastoidea, which also afford it protection.

The well-known change which the lower jaw undergoes with increasing years is often very marked. The ramus, almost vertical in adolescence, and joining the body of the bone at a right angle, becomes afterwards reduced in size, more oblique, and the angle obtuse; where early loss of the molar teeth has occurred, this takes place sooner.

Under this change, the jaw has a very much increased range of motion sometimes, the acts of opening the mouth widely, as in mastication and yawning, causing the anterior wall of the concha, just below the tragus, to be drawn downwards and forwards, as the condyle rides forwards. Naturally, the condyle is always carried forward about one centimetre in opening the jaws, while the fibro-cartilage is also displaced, but in an opposite direction; in the words of Sappey, "the condyle slides on the fibro-cartilage of the glenoid fossa from behind forwards, while the fibro-cartilage slides on the condyle from before backwards." Distressing acoustic phenomena are common in subjects having this undue range of motion in the temporo-maxillary articulation and where anomalies also exist in the drum's tension, the

effort of yawning under these conditions putting the drum-head unduly upon the stretch. The act of yawning also causes, through contraction of the tensor muscles of the palate, tension upon the hammer through the tensor tympani. The rapid variations in auditory tension, both from without and from within, give rise to autophonia and other symptoms.

The following cases are illustrative of the above:

Case I.—Male, 51 years of age, of large osseous and muscular development, but thin. Motion of temporo-maxillary articulation during movements of jaw can be plainly seen on looking into the concha. With each movement the lumen of the aërial conduit is almost obliterated, the condyle becomes very prominent in front of the tragus, which is bent forwards upon itself, and the auricle is made to rotate anteriorly upon its axis. If the finger be placed in the meatus, which is large enough to admit its end, it will be *very decidedly squeezed* when the jaws are widely opened. The drum-heads, unusually large and relaxed, show the presence of trophic changes. The patient always experiences dizziness, and is usually nauseated from masticating his food—phenomena due to variations of drum tension. Occasionally the vertiginous condition comes on at other times, entirely preventing locomotion. There is constant autophonia and a feeling of confusing numbness about the ear. When moderate traction on the auricle is maintained, this symptom is relieved, and hearing is improved. These experiences have finally made the patient exceedingly nervous, and he is no longer able to attend to his business. He has been treated by many physicians, one of whom regarded his trouble as gastric.

Case II.—Male, 21 years of age, a subject of chronic aural catarrh, the drum-heads being greatly relaxed. The temporo-maxillary articulations admit of unusually free motion of the lower jaw, even moderate separation is attended with lateral displacement. This is most marked on the right side, where the coronoid process can be felt to impinge very much on the cartilaginous canal, if the finger be placed in the right concha; the movement may be observed also by the the eye. Patient is subject to exacerbations of head catarrh when the autophonia is much more marked, especially on the right side. Temporary relief follows voluntary sub-luxation of the lower jaw, short but vigorous efforts of expelling air from the nose, slight inflation by the Valsalvan experiment, or traction upon the concha, all of which may be made to restore the drum tension. The large size of the canals and drum-heads permits easy inspection of the latter, which, during inflation, are greatly relaxed; they may be seen to move in and out during intra-tympanic inflation and rarefaction. The shock from the inflation occurring on blowing the nose once gave rise to vertigo and falling to the ground. It is notable that, while moderate inflation improves the hearing, decided inflation forces the drum-heads out too far and increases the deafness.

Baron D. J. Larrey, in "Observations on Wounds," etc.,[1] alludes

[1] Ed. 1832, Philadelphia, page 254.

to the encroachment of the condyle of the lower jaw upon the canal as a cause of deafness, alleging that this result is due to obliteration of the walls of the canal, whereby "the rays of sound can no longer reach the tympanum." That the closure of the canal interferes with the entrance of sound is doubtlessly true; but the principal cause of deafness in these cases is interference with the tension of the transmitting mechanism.

In inflammation of the external auditory canal, and of the middle ear, mastication is often attended with much pain.

FURTHER REMARKS ON THE EXTERIOR MUSCLES AND FASCIA OF THE EAR.

The exterior muscles are but seldom under the voluntary control of man to the same extent witnessed in lower animals, but, as will be seen in another part of this work (p. 30), numerous cases occur where the voluntary control of these muscles is present in a remarkable degree. The writer is convinced from his own observations that, acting voluntarily, these muscles are of the greatest importance. Most persons, however, possess the ability to voluntarily make tense the membrana flaccida through contractions of the superficial muscles, the act being doubtlessly attended with the unconscious performance of several functional movements connected with the *modus operandi* of audition; thus the M. incisuræ Santorini, together with the auricular styloid muscle (p. 11), when in action, enlarge and stretch the cartilaginous canal, and it would seem even possible for the canal to be further acted upon by so remote a muscle as the styloglossus, whose special function it is to draw the tongue upwards and backwards.

The *posterior auricular muscle* is frequently found sending fibres of insertion to the sterno-mastoid and trapezius muscles. When acting in conjunction with these muscles, the effect would be to very much increase its power of drawing the auricle backward and of dilating the external auditory meatus.

The frequent anomalous development of the exterior aural muscles in man, when contrasted with the constant existence of more efficient muscles in the lower forms of animal life, enables us to form a better idea of their functions in the former.

This entire group of muscles then may be regarded as having no other use than acting upon and regulating in various ways the movements of the auricle and external auditory canal. Some of the movements of the auricle are of interest here. Thus, in persons having

the power to voluntarily move the cranial aponeurosis freely, the temporal muscle may be seen during mastication to bring into action both the superior and anterior auricular muscles, the auricle often being elevated as much as a quarter of an inch with each contraction of the superior auricularis.

Many individuals are able to draw the auricle backwards, but much more frequently forwards and upwards. While it is true that the integumentary lining, including the skin, of the exterior outlet maintains the normal state of tension in the drum-head, the fascia of the anterior wall, to which the tendon of the anterior auricular is attached at the outlet of the osseous canal, responds to contractions of the latter muscle and its auxiliaries, the frontalis and orbicularis, through which the tension of the membrana flaccida is increased.

The consequences of impairment of tympanic tension through relaxation of the exterior parts are mentioned elsewhere; the swelling of these parts from inflammation also has its significance, such changes giving rise to phenomena which, if rightly interpreted, may aid very much in forming a diagnosis from symptoms otherwise perplexing. Autophonia is common to diseases affecting both the external and middle ear, yet often differs sufficiently to very much facilitate making a differential diagnosis.

The movements consequent on voluntary action of the exterior aural muscles are perceptible to both sight and touch, and the same may be said of their unconscious action; thus the *arrectus auris* or *auricularis superior* may often be observed in persons when intently listening, the auricle being gradually raised, though not always appearing to be out of place until relaxation occurs, when it may be seen to suddenly gravitate down to its usual position in repose.

In order to demonstrate the motion of the exterior muscles, especially that of the anterior auricular, as transmitted through their tendinous connections with the membrana flaccida, the writer, assisted by Dr. S. H. Pinkerton, made a dissection of these parts in a recent subject.

First the deep temporal fascia was dissected up to where it is blended with the anterior ligament of the auricle. At this stage of the proceeding, it was found that traction on the deep temporal fascia moved the auricle freely. The anterior attachment of the auricle was then divided, and a section of the petrous bone was made by sawing down through the typanum from above, separating the incus from the stapes and bisecting the tensor tympani muscle in its bony canal, leaving the rest of the mechanism of the middle ear intact, with the

exception of a slight laceration of the drum-head at its inferior segment. It was now found that if that portion of the tensor tympani left attached to the manubrium mallei was made taut and so retained in the grasp of forceps while traction was made as before on the temporal fascia, which had been dissected up, the transmitting mechanism responded promptly and became more tense than before. When alternate tension and relaxation was practised on the fascia, the drum-head tightened and relaxed likewise, the motion being perceptible to the eye. These apparently demonstrable influences of muscular action in the middle ear mechanism in man are similar to those which, in a more perfect manner, are probably obtained in the horse, dog, and other animals by means of the voluntary action of their more efficient muscles.

A knowledge of the significance of the relations between the exterior parts of the ear and the middle ear mechanism which the author has attempted to outline, enables us to account for some of the phenomena produced by alterations in the tension of the transmitting apparatus, whereby the normal equilibrium is altered. Thus, the membrana tympani may have its tension very much disturbed by alterations in the tone of the cutaneous lining of the ear, or of the fascia and muscles connected with it. An explanation may thus be found for the variation in hearing experienced by persons who alternately pass their time in the cold bracing out-door air, and in warm apartments; the toning-up effects of the former improving hearing, while relaxation and dulness of hearing occurs from atmospheric humidity or in-door warmth.

The cartilage of the canal and pinna are frequently found collapsed in old age. The lumen of the canal becomes thus almost obliterated, the inner wall of the concha falling over the opening of the meatus. and, from loss of tone in the skin, fascia and muscular structure as well as in the cartilage, the entire exterior ear drops down from want of its natural support, leaving the skin in front of the tragus, and sometimes behind the auricle, deeply wrinkled. It is probable that this relaxation is accompanied with a certain amount of compensatory tension due to the more dependent position of the auricle; it will be found, however, very soon that lifting the auricle upwards, backwards, and outwards or pushing it downwards by placing the finger in the concha, is necessary to clear up the dulness of hearing occurring in many of these cases.

In practice one constantly meets with disturbances of tension in both chronic and acute catarrhal inflammation of the middle ear, both purulent and non-purulent; furthermore, in cases where a mano-

metric membrane exists, in inflammation of the external auditory canal, and where ceruminous collections become impacted. The following are cases where relaxation has occurred consequent upon chronic catarrhal inflammation of the middle ear.

CASE 1.—Male, 42 years of age. Fifteen years ago contracted syphilis, since which both nasal and aural catarrh has become severe, and deafness very decided. Owing to alterations in the transmitting mechanism, excursions of the membrana tympani have been attended with sensations of the ear being alternately opened and closed "like a door." The autophonous phenomena, which are very distressing, are relieved *when the patient turns the affected ear downwards; returning again when the organ is turned upwards. Relief is obtained also by pulling the auricle outwards whenever autophonia is present.*

CASE 2.—Female, 43 years of age. Long-standing chronic catarrhal inflammation of both drums; autophonia and deafness most marked in the right ear, symptoms which are relieved by traction made by placing end of finger in the concha.

CASE 3.—Male, 47 years of age. Catarrhal inflammation of drums of long standing. For the relief of deafness of right ear the patient has the habit of pulling out and shaking the auricle.

CASE 4.—Male, 40 years of age. The long-standing chronic catarrhal inflammation of drums is accompanied by autophonia in the right ear. An exostosis on the posterior wall of the right external auditory canal near the drum-head seems to increase the trouble. For past week the right ear has a feeling of being "stuffed with wool." Patient has long had the habit of easing the "stopped up" feeling in right ear by placing the forefinger in the concha and drawing the parts outwardly.

CASE 5.—Male, 35 years of age. Very great deafness due to chronic catarrhal inflammation of the drums. The skin about the auricle is relaxed and wrinkled. Has the habit of shaking auricle to "clear the hearing." Experiments showed that when the outer parts were put on the stretch, high notes could be heard much better.

CASE 6.—Male, 63 years of age. Has long had chronic catarrh of the drums and the drum-heads show trophic changes. For a long time slightly deaf, but since attack of typhoid fever one year ago the hearing is so much worse that he cannot carry on ordinary conversation. The occasional autophonia is very distressing. He relieves this and also improves hearing by making traction on the auricles with the fingers.

CASE 7.—Male, 50 years of age. This professional singer sings out of tune. Has chronic nasal and aural catarrh. The "ears close," and gentle traction on auricles "opens" them again.

CASE 8.—Male, 51 years of age. Has parchment-like drum-heads,

with loss of tension throughout both transmitting mechanism and the outer parts. The symptoms of autophonia and deafness are sometimes relieved by gentle traction; but if done violently the trouble is increased.

CASE 9.—Male, 55 years of age. The chronic catarrhal inflammation of the middle ear gives rise to dumb feeling in the ears and autophonia, both symptoms being relieved by traction on the auricles.

CASE 10.—Male, 40 years of age. Long-standing and severe nasal and aural catarrh accompanied by great deafness. The right drumhead was once ruptured by a blow on the ear; it seemed to increase the defectiveness of the transmitting mechanism. Hearing is improved by pressing auricle forward with the open hand until folded upon itself. The improvement was notable both for the watch and voice.

The following are cases where auditory tension was affected by acute inflammation of the middle ear:

CASE 11.—Male, 53 years of age. A cornet player. Since attack of acute aural catarrh a few days ago the voice and cornet sound autophonously in the left ear. These phenomena disappear on making traction on auricle.

CASE 12.—Male, 51 years of age. An attack of acute purulent inflammation of the middle ear gave rise to autophonia and very disagreeable rumbling sounds in one ear; both were stopped by *gently* drawing upon the auricle.

Cases where chronic purulent inflammation gave rise to altered tension.

CASE 13.—Male, 14 years of age. Left ear has been running for six years. Has long had the habit of pulling the auricle of the affected ear to "clear the hearing."

CASE 14.—Male, 23 years old. Has had since infancy purulent inflammation of the right tympanum, especially of the attic, with deafness for low sounds. He can voluntarily move the auricles backwards very freely, the right most, from practice perhaps in his efforts to hear. Hears both voice and watch better when ear is voluntarily elevated. Hears best in a noise.

CASE 15.—Male, 34 years old. One ear has long discharged and is the seat of much tinnitus which is stopped by drawing out the auricle.

CASE 16.—Female, 47 years of age. Ears have been running for many years. Deafness much increased by pushing in the auricles, and is improved by pulling them out.

CASE 17.—Female, 25 years old. The deafness and autophonia,

due in this case to chronic purulent inflammation of the middle ear, was improved by lifting the concha upwards and backwards.

Case where auditory tension was affected by large perforation.

CASE 18.—Male, 31 years of age. The left membrana tympani has a large perforation. There is no discharge. Voice sounds cavernous in the ear, "seems to come from a barrel." Drawing left auricle forward with open hand relieves this entirely.

Case where auditory tension was disturbed by a manometric restoration.

CASE 19.—Female, 32 years of age. Hears best in a noise. Watch heard best when auricle is drawn outwardly.

Case where the membrana tympani was almost entirely absent.

CASE 20.—Male, 42 years of age. The membrana tympani has long been very nearly entirely absent, the membrana flaccida and chain of ossicles remaining in a defective state. There is of course an entire absence of equilibrium in the transmitting mechanism, and the hearing varies in the most eccentric manner. Good hearing can be temporarily brought about if the membrana flaccida be made tense by traction on the auricle.

Cases where the auditory tension was disturbed by desquamative inflammation of the external auditory canal and by the impaction of cerumen.

CASE 21.—Male, 59 years of age. Has desquamative inflammation of the external auditory canal with seborrhœa. When an accumulation has formed, the ear becomes very uncomfortable from its impaction against the drum-head; relief is instantly obtained by drawing the auricle outwardly and then shaking it, *thus showing the possibility of carrying the mass away from the drum-head upon the moving dermis which is made to glide over the bony canal.*

CASE 22.—Male, 51 years of age. Collection of soft cerumen impacted in left ear, causing "numbness." Relief is obtained by making traction on auricle.

CASE 23.—Male, 67 years of age. Canals are collapsed within lumen. Has considerable deafness, but it is much less in cold weather. The "cloudiness" in the right ear is removed always by placing the head of a lead pencil in the canal and making traction outwardly. The case came for treatment on account of the retention of the soft rubber head of a pencil in the ear.

CASE 24.—Male, 45 years of age. Soft wax is impacted in both ears against the drum-heads; brought about by a fall on the ice six years ago. There was continual deafness for a few months after the fall, and ever since occasional impactions accompanied by a "crack like a cannon shot." On giving the ear a "jerk," hearing remains

good for half an hour. On getting up in the morning he cannot hear at all until he puts his finger into the conchæ and gives them a "shaking up," when he hears for a time.

The cases just given have been selected from the records of a large number of similar ones. In a great number of instances the writer has been told by patients that gentle pressure with the forefinger upon the lower edge of the concha "clears up their hearing" temporarily. The act is very often unconsciously practised by the patients when troubled with an uncomfortable feeling in the ears, due to disturbance of equilibrium in the transmitting mechanism.

In one instance, a patient, 20 years of age, could relieve autophonous symptoms at times by pressing upon the tragus.

OBSERVATIONS ON THE COMPARATIVE PHYSIOLOGY OF THE AURICLE.

The voluntary ear movements of some of the more common forms of animal life below man in the scale, such as the horse, dog, and cat, are very remarkable, the ears of these mammals being capable of performing an almost complete revolution upon their axis. In the dog and cat the auricular cartilage is much more soft and flexible than in man, and the skin muscles, though delicate, are exceedingly efficient. Accustomed as we are to estimate muscular force by the biceps of the blacksmith or athlete, we are scarcely prepared to reckon the power of the skin muscles which lie within our grasp when handling the loose hide upon animals, that of the dog, in particular, whose entire scalp slides freely over the skull, yet with what energy they agitate the skin at will! The auricle in these quadrupeds, which is so loosely attached to the head, and so easily compressed when in close quarters, is very effectively employed in gathering sound. In the act of listening, the convexity of the auricle is presented in different directions until the source is discovered, and every observer is familiar with the widely expanded, erect auricle of animals as this takes place.

Birds having no outstanding auricle turn the head rapidly in all directions until the source of sound is discovered, when the head is held with one ear cocked up in the direction from whence it comes.

During the visit at the country residence of a friend, the author availed himself of the opportunity offered to examine the ears of some of the dogs of the kennel. It was found in setters and other dogs where a strain of spaniel prevails, that the drooping ears seemed to afford a natural shield to the deeper and more delicate parts of the organ, which are much exposed in these frequenters of the water and

rovers of the field. The cartilage of the pinna, however, is no larger than in breeds carrying their ears erect, being absent in the most pendent part, and that portion composing the commencement of the external auditory canal is much dilated, forming a very large concha, which, when the external ear is in repose, contracts into folds like the mouth of a purse, thus protecting the ear from the entrance of foreign bodies, etc. When the pendent portion of the auricle is lifted up, so as to afford a better view of the entrance to the external auditory canal, there are to be seen a number of operculæ, formed from the outer margin of the collapsed walls; one of these, larger than the rest, seems to correspond to the tragus in the human ear. When the animal is on the alert in listening, the drooping auricle is lifted up and expanded, and the pliant cartilage unfolded, the act being performed by the retrahens aurem and attolens aurem, which muscles together lift the auricle backward and upward with much energy, thus bringing a most efficient sound-collecting trumpet into use.

The hearing is possibly further improved in fielding by the constant motion of the dog's head, his ears being thus frequently thrown up, the act giving greater exposure to the concha. The act of expanding the auricle would seem to also render the drum head more tense, and, on the other hand, the dog is observed to droop his ears to loud and disagreeable sounds, the drum-head being probably relaxed in this way, while, at the same time, sound is more completely excluded by the collapse of the cartilage and the more overlying and pendent auricle. In this manner, more or less complete muffling of the sound-transmitting mechanism takes place, without which the sensitive hearing organ possessed by these animals would be liable to injury from loud sounds.

A gentleman, a close observer of the habits of animals, who came from Ohio to consult the writer, has frequently seen a young spaniel in his possession throw up its ears with marvellous quickness on hearing very distant sounds, remaining in this attitude for some moments, as though straining to detect their source and nature. He also has observed that during a thunder storm the dog would droop the auricles, and throw back his head, his distress from the painful sounds being manifested by every act.

The same gentleman informs the author that, in witnessing the combats between cats, he has been struck by the characteristic position in which the auricles are placed when the enraged felines rush into the arena to begin the contest. The organ is drawn firmly backwards and somewhat downwards, out of harm's way, this act closing

the entrance to the ear. While both animals now give utterance to the most distracting noises, each seems to thus exclude the cries of the other. The eyes are also kept almost closed. Finally, at the end of the struggle, the conquerer will throw up his auricles, in token of victory, the moment he obtains the advantage.

It is a well-known fact that the horse, when viciously inclined, throws his ears far back, an act analogous to that of a desperately angered person who shuts his eyes to the consequences of his own inconsiderate passion, and may be said to blindly rush on to his own destruction; so might one fancy that the horse, by means of this position of the ears, excludes sound to some extent, and thus dulls one of the senses through which his submission might be brought about.

Gallinacea, and probably most birds, have a feathery cluster as an outward sound collector, the auricle existing as a mere protective cartilaginous operculum at the entrance of the external auditory canal. The external auditory canal in the domestic hen being large, the parts may be readily studied by dissection. The writer has always found the membrana tympani to be also comparatively large—half the size of that in man. The arrangement of the membrane lining the canal is particularly interesting; this is not attached to the posterior and superior walls, but glides freely over them, being directly continuous with the membrana tympani. Some muscular fibres seem to blend with this movable fascia, and *traction applied to the muscular tissue behind the ear puts it on the stretch, and can be seen to make the drum-head tense.* The semicircular canals are known to be very large, but the writer was surprised to find how great an area of the temporal bone was occupied by the pneumatic cellules, which are of very small size.

The auricle in man has a more inflexible framework, and is much less mobile than that of the quadrupeds described above. It is flattened out rather than puckered up, but the tragus projects well over the lumen of the canal, affording it protection. The flexible auricle of the dog, when unfolded, presents with the cartilaginous canal a cone-shaped tube. In man, the outer cartilaginous parts fall away from the osseous canal into which they are telescoped in a downward direction, the traction of their weight contributing to the maintenance of tension in the transmitting mechanism.

THE FUNCTIONAL MOVEMENTS OF THE AURICLE.

The cartilage of the outer ear is capable of very much more motion than many suppose. The concha, in the first place, is bent over upon, and lies in close contact with the cartilage of the canal, and may easily be lifted away from it; in the second place, the cartilaginous canal lies loosely in its place, and the fissures of Santorini increase the range of its motion.

It has been stated that the principal point of connection between the auricle and the temporal bone is at the greatest convexity of the concha. This point indeed *would seem to be the axis about which the auricle may be revolved rather than the cartilaginous canal.*

Now it will be seen that the ligaments which support, and the muscles which act upon the auricle anteriorly, are attached somewhat *above* this axis to the tragus and spine of the helix, whilst the ligaments which support and muscles which retract the auricle are inserted posteriorly *on a lower level* than the axis. When the auricle is drawn forwards by the anterior muscles it rotates on the axis; when retracted by the posterior muscles, a similar movement takes place. The superior muscle alone, seldom, if ever, acts independently so as to elevate the auricle, although it does so in connection with the anterior muscles. The tragus partakes of but little of the auricle's motions. When the auricle is lifted upwards by the surgeon, so as to bring the cartilaginous canal on a line with the osseous portion, in making an examination of the deeper parts, it first glides over the cartilage of the canal to a considerable extent before traction is transmitted to the canal itself. Further traction then elevates the canal, its transverse fissures increasing the length of the anterior wall, while the posterior membranous wall, in consequence of its loose attachment, is bent in such a manner as to become shortened. That portion of the concha lying between the line of the tragus and antitragus glides freely up and down in the space between the ramus of the jaw and the mastoid process when traction is made above or below—a movement very much facilitated by the first tubal fissure. The lower edge of the cartilage of the concha may be felt just above the lobule, and *if the finger be placed in this cavity, and pressure downward be made, the incisura auris* may be felt to present a triangular groove looking upward.

Persons with defective hearing, due to relaxation of the integument covering the external auditory canal and drum-head, frequently practise this so as to bring the integumentary lining into a state of tension, and thus increase the hearing power. On the other hand, *the*

acuteness of hearing may be decidedly lessened by pressing these parts upwards and inwards.

THE VOLUNTARY MOVEMENTS OF THE AURICLE IN MAN.

Aside from affording a trumpet-like channel for the entrance of sound to the drum, the auricle also maintains its tension, a function due to its elasticity. Physiologists have long accepted the theory that the proper tension of the drum-head depends on intrinsic tractile force which the tensor tympani exerts—a conclusion reached through deductions drawn from accepted principles. The observations of many years in the field of practical otology have led the author to question this belief, since many pathological conditions of the ear give rise to phenomena going to show that the tractile energy on which tension of the drum-head depends, lies rather in the resilient cartilage of the auricle. The induction has been further fortified by (*a*) studies of the functions of the hearing organ in lower animals, (*b*) anatomical studies of the ear, (*c*) observations of ear movements in man, especially when displayed in an unusual degree, and (*d*) from the phenomena attending morbid conditions of the auditory apparatus. The three former are alluded to elsewhere; the fourth remains to be considered.

It has been already stated that, if close observation is made, most persons when listening exhibit in some degree the unconscious elevation of their auricles. The muscles by whose action this function is performed are, as is known, comparatively feeble, yet they are sufficient for the requirements of the auditory apparatus in man. The ability to voluntarily move the auricle possessed by some is a strong argument in favor of evolution. The writer has observed that, perhaps, more than one-half of all the patients examined perceptively move the auricle upward and forward or upward and backward, on the mere contact of the instruments used in examination or treatment of the ear; sometimes this action actually impedes their use, the patient seeming to unconsciously remove the organ out of the way. In a much more perfect manner, extraneous objects are excluded from the ears of some animals whose rudimentary auricles seem specially provided with this function. Numerous observations have shown that the faculty of using these muscles varies in different individuals; some could contract either the frontalis, orbicularis palpebrarum, or occipitalis, while others could not make the former act without bringing into action the two others. The orbicularis alone was some-

times found to have the power to move the fascia temporalis and, in consequence, the auricle and even deeper parts of the organ.

Arrectus Auris: A friend of the author's, in conversing, always elevates his eyebrows quite unconsciously while listening, by contracting the frontalis muscle. In order to ascertain if the acuteness of hearing was thus increased, the writer placed a vibrating tuning fork just out of the perceptive range of this gentleman. On elevating the eyebrows smartly, the vibrations could then be heard, and when the former were again relaxed he ceased to hear them ; alternate contractions and relaxations of the muscle, rapidly made, caused the sound to reach his ears interruptedly, some object seeming to be now and then interposed, as he expressed it. Similar results were obtained with a watch while ticking. An observant otologist informs the writer that he has known a person who always elevated his eyebrows so greatly as to appear supercilious and overbearing, or as if he seemed to doubt what was being said.

In consequence of old age, and sometimes in younger persons, from certain causes, relaxation of the skin of the outer parts of the ear is liable to occur, giving rise to loss of tension in the drum-head ; impairment of hearing and autophonia are then liable to occur, and patients very often acquire the habit of placing the open hand behind the auricle *to draw it forward while listening.* In thus increasing the sound-collecting capacity of the organ and putting the parts upon the stretch, hearing is considerably aided. Others attain the desired result of making the drum-head more tense by placing the forefinger in the concha and making traction, and even shaking the auricle vigorously while drawing it outwardly. While these manipulations affect the transmitting mechanism but little when in a normal state, yet their effects are notable where its equilibrium has been disturbed through loss of tone in the dermic layer of the drum-head and external auditory canal. Where, furthermore, autophonia is due to partial luxation of the malleo-incudal, incudo-stapedial, or stapedial-fenestral articulations, this outward traction is found to temporarily restore tension and remove the disability. It is probable that the temporary improvement of hearing by inflation of the drum after Politzer's method is accomplished in this manner.

Some years ago, while examining a patient, the temporalis muscle was observed to involuntarily contract on touching the meatus with a speculum, and *the skin in front of the tragus, which was wrinkled before, became smooth and even tense.* The patient, who could contract these parts at will, informed the author that *accompanying the action he always experienced a "crack" in the ear.* From the notes of

many subsequent observations on this subject, the following, which offer points of unusual interest, have been selected.

CASE 1.—Joseph C——, aged 14, came to the New York Ear Dispensary, in November, 1878, on account of defective hearing arising from chronic purulent inflammation of the middle ear. During his examination, it was observed that he readily pricked up his ears while listening, the auricle presenting well forward. The act seemed to be performed as if to aid the defective sense of hearing, and he was apparently unconscious of the movements made. When requested to move his ears, however, they were moved forward and backward with great ease. The power of moving the ears was doubtlessly increased by the constant efforts made in listening.

CASE 2.—This case was that of a friend of the writer, a physician about 38 years of age, of slender build, and having free muscular action throughout. At school he was noted for the facility of ear movements. By the conjoint action of the occipital and frontalis muscles, he could elevate and displace his hat, but not quite throw it off the head. On bringing the aural muscles into play for the writer's inspection, it was found that long disuse had in a manner deprived him of the power once possessed in moving them, and the efforts made soon tired him. After resting a few moments, however, he was able to proceed again; when the occipital muscle was now contracted, the fascia containing the *retrahens auris* became tense, and, by the aid of the auxiliary force on either side, the auricles were retracted and bent over upon themselves, the folding commencing at the antihelix, specially along the posterior superior border. Altogether the auricle was drawn upward as well as backward; the auriculo-cranial fibres of the fascia thus put on the stretch were felt during the action to be very tense. No ability to draw the auricle forward was detected.

CASE 3.—Miss Sarah ——, aged 22, slender and, like all cases of this kind, possessing much suppleness of movement. Three years ago she began to notice the ease with which the muscles of the head could be brought into action; at first she observed that she could move "the top of the head," and shortly afterwards the ears. On request, she brought the occipital and frontal muscles into violent action with great ease, then elevated the brows, and contracted the orbicularis independently. The demonstration of ear movements on both sides was very remarkable. By the action of the occipitalis and posterior auricular, the auricles could be drawn backwards and slightly upwards with great promptness and energy. A finger placed just behind the auricle, on a plane with the external auditory canal, detected vigorous contractions of the retrahens and fascia in which the latter lies; even the integument in front of the concha was drawn towards that part, and the skin below the auricle and down over the side of the face and neck for some distance was visibly affected. There seemed to be quite a decided independent action of the retrahens muscles, the ears to all appearances being moved at will by these muscles; but when aided by the occipital and frontal muscles, the ears could be moved

much more decidedly. The latter experiment being kept up some minutes, she complained of being tired; in fact, *several vigorous contractions always make her dizzy—a phenomenon seemingly due to the concussions imparted to the fluid in the labyrinth.* She said that during the ear movements she could "feel something move inside her face." *This suggested that contraction of the tensores tympani, together with the tensores palati, had taken place.* and, on making the attempt, it was found that this could be voluntarily done. When the tensors of the palate were thus in a state of contraction, exterior noises seemed distant, and a peculiar "vacuum" in the ears was experienced. The following acoustic observations were now made:

It was found that a ticking watch could be heard nine feet, but if moved several inches further away, she could again hear it on drawing up the auricles, as before. If the watch was now held in front of the face, it was well heard at the distance of five feet, but if the tensors of the palate and tensor tympani were now contracted, it could no longer be heard. When she ceased to contract these muscles, a peculiar sound was experienced in the ears and hearing returned. It was observed that the auricle, while under muscular dominance, after being drawn a certain distance either backwards or forwards, was slightly rotated on the axis of its ligamentous attachment to the skull.

CASE 4.—Eugene F ——, aged 22 years, Frenchman, of slender physique. Through the action of the occipital and frontal muscles, this person can move the scalp with extraordinary freedom; when the muscles act independently of each other, the ears are drawn either backwards or forwards. When drawn well back, if traction be maintained, the helix is bent over upon the auricle. The temporal and post-aural fascia can be seen and felt to move during the action described. This exercise gives rise to a tingling sensation at the sides of the nose and about the auricle; subsequently, these parts have an "exhausted feeling" like any other region under severe muscular usage. He can hear the ticking of a watch much farther when the auricle is drawn in an upward direction. He is musical and when listening to orchestral music often finds himself wagging his ears to the time of the air being played. The auricle, during some of the exercises, was seen to rotate considerably upon its axis, and after a time became deeply flushed; when erected it was held rigidly against the temporal bone. When the auricle was taken by the helix and drawn forward, the tendons of the posterior auricular stood out plainly on voluntary contraction being made; it returned to its place when the muscles were voluntarily relaxed. These muscles become more or less inert after exercise, but after a few moments' rest their use would return.

CASE 5.—This patient is a German teacher, aged 29 years. By voluntarily contracting the orbicularis palpebrarum, the temporal fascia is made sufficiently tense to draw the auricle forward and upward; the fibres attached to the anterior border of the helix during this action become so tense that they feel like the tendon of some strong muscle. The tragus remains fixed during the ear-movements,

while the posterior wall of the cartilaginous portion of the external auditory canal is advanced considerably, increasing the vertical diameter of the lumen, at the expense of its longitudinal diameter. The occipital and frontal muscles have a free action also, but the action of the orbicularis was quite independent of these.

CASE 6.—Mabel ——, aged 13 years, of slender build. Can voluntarily move the auricles both upward and backward, the superior border of helix being slightly bent upon the auricle. When the speculum is gently introduced just within the meatus, the skin of the canal can be seen to move outwardly when the auricle is drawn backwards.

Examples like the above might be multiplied ad infinitum, since in a large number of young and slightly formed persons these phenomena can be plainly seen.

CHAPTER II.

OBSERVATIONS ON THE TRANSMITTING MECHANISM OF THE DRUM OF THE EAR.

The drum is not a sound-producing instrument in the ordinary sense, and when the drum-head is beaten upon by the gentle pulses of the air no perceptible aërial sound is given forth, but the drum-skin is set in motion by the undulatory movements, constituting sound, and its propulsive action, through the malleus and incus bones, sets the piston-like stirrup bone in motion, thus giving rise to vibrations of the labyrinthine fluid and motions of the otoliths. Similar action may take place in the cochlea through vibrations also set up in the membrana tympani secundaria. The drum of the ear or tympanum, therefore, receives and transmits sound. This portion of the auditory tract constitutes what may be designated the aërial region. Before speaking further of the *modus operandi* of hearing, a brief description of the anatomy and physiology of the parts will be given in order to make the subject more readily understood.

A. THE DRUM OF THE EAR.

The boundaries of the drum (middle ear) are: inwardly, the osseous tympano-labyrinthine partition; outwardly, the drum-head; and laterally, an almost continuous narrow wall. The drum is very shallow, being only a few lines in depth. Its inner and outer boundaries are almost flat; its lateral aspect circular. It has a free vent into the throat by means of the Eustachian tube, and communicates with an extensive but irregularly-formed air chamber, the mastoid antrum, through a tolerably large bony canal and the cellules of the mastoid and neighboring parts. Because of its moist lining and other characteristics, the drum is not ordinarily resonant, but should in this connection be regarded simply as a transmitting mechanism.

For an anatomical description of the bony parts of the middle ear, the reader should consult Chapter XI.

B. THE MEMBRANA TYMPANI.

The drum-head is a thin, elastic, membranous partition stretched over the bottom of the external auditory canal, pearly white in color, and polished. In its tissue the handle of the hammer is so fixed that it partakes of its movements.

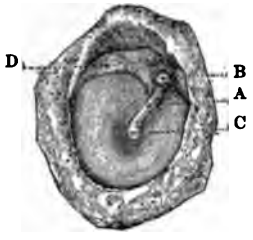


FIG. 9.—OUTER SURFACE OF DRUM-HEAD (GRUBER).

A, Manubrium of malleus; B, short process; C, tip of the manubrium, the umbo; D, posterior fold.

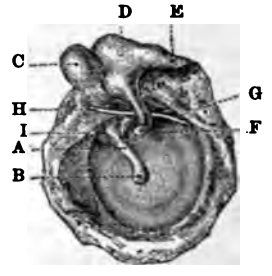


FIG. 10.—INNER SURFACE OF DRUM-HEAD (GRUBER).

A, Manubrium of malleus; B, umbo, or tip of the manubrium; C, head of the malleus; D, body of incus; E, short process of incus; F, processus lenticularis of incus; G, H, chorda tympani; I, insertion of tensor tympani muscle.

It is divided horizontally into two unequal portions, to which Shrapnell gave the names of membrana flaccida and membrana tensa.[1] The smaller, the *membrana flaccida,* Shrapnell's membrane, or, as it might be properly called with respect to its functions, the ***tensor of the membrana vibrans*** is situated above, whilst the larger, the *membrana vibrans* or tensa is placed below. Each portion has different functions.

The *membrana flaccida* is continuous with the integument lining the external auditory canal which, after passing over the vaulted upper wall of the canal, curves downward at a very obtuse angle, passing over the gap which, in infancy, is left between the horseshoe-like annulus tympanicus, as it rises to the auditory plate; it is then reflected off the edge of the auditory plate, and passes downward somewhat in front of the atticus tympanicus.

The *membrana vibrans* or *tensa* is stretched below in front of the atrium, and is framed into the groove at the end of the external auditory canal.

The external face of the *membrana tympani* is concavo-convex; from above the malleus handle may be seen to extend down along

[1] On the Form and Structure of the Membrana Tympani. By Henry Jones Shrapnell. The London Medical Gazette, April 28th, 1832, p. 122.

its median diameter ending near the centre in a depression, the *umbo*.

The projection of the short process of the malleus handle pushes outwards the membrane at the junction of the two portions of the latter. The membrana vibrans is attached below at an acute angle with the floor of the drum, to its anterior wall at an acute angle, and to its posterior wall at an obtuse angle. It forms an angle of 55° with the axis of the canal, and one of 15° with the longitudinal axis of the body.

C. THE MUSCLES OF THE DRUM.

The muscles of this part of the auditory apparatus are those of the malleus and stapes.

1. *M. tensor tympani*, or, as it has been called, *M. mallei internus*, arises from the anterior mouth of the muscular and upper wall of the cartilaginous portion of the Eustachian tube, "from the pyramidal petrous portion of the temporal bone, which here forms the lateral and anterior wall of the carotid canal . . . also from the neighboring edge of the temporal wing of the sphenoid, where it unites with the origin of the spheno-staphylinus muscle (see p. 48) by tendinous and ofttimes muscular fibres" (Henle). It traverses upon the Eustachian tube, becoming surrounded by a fibrous sheath, from which start some of its fibres. "It passes over the septum tubæ into the canal of the tensor tympani which it traverses from one end to the other, fortified by short oblique fibres arising from the superior wall of the canal. Just before its exit into the canal it assumes the form of a cylindrical tendon, which winds around the cochleaform process and then passes through the tympanum at right angles to the body of the muscle" (Henle), and is attached on the upper end of the median edge of the handle opposite the short process. The tendon, according to Sappey[1] and Helmholtz,[2] is contained in a sheath (tensor ligament of Toynbee) which is lined with a synovial membrane, but Magnus claims that it is only covered by the mucous membrane of the drum, strengthened by firm submucous tissue. The *otic ganglion* furnishes the motor nerve of this muscle. Politzer[3] and Ludwig have proved by experiments, however, that the motor elements of this *nervus ad tensorem tympani* belong to the motor portion of the trigeminus.

[1] Anatomy, p. 541.

[2] Die Mechanik der Gehoerknoechelchen und des Trommelfells. Pflüger's Archiv für Physiologie, I. Jahrgang.

[3] Diseases of the Ear. Trans. by J. P. Cassells, Phila., 1883, p. 44.

Its action, according to most authorities, is to pull the hammer inward and to turn it about its longitudinal axis, which action Kessel believes stretches the anterior segment more than the posterior, thus admitting of a simultaneous perception of high and low tones. But opinions differ in regard to the functions of this muscle. Magnus,[1] for instance, thinks the muscle is too firmly attached in the canal, and its tendon in the mouth of the canal, to exert any influence on the membrana tympani. He regards its function (and also that of the stapedius muscle) as confined to aiding the elastic resisting power of the tissue which surrounds the tendons at their point of exit. Henle[2] says the action of these muscles is necessarily limited, since the bony walls in which they lie prevent the swelling necessary to much contraction. The muscles do not maintain the position of the drum-head as much as their sheaths.

2. The *stapedius muscle* starts from the depths of its bony canal, at the base of the *eminentia stapedii.* The belly of the muscle fills the canal and, becoming thinner and pointed, it passes out of its opening on the pyramid in the form of a brilliant, bristle-like tendon of one line in length, which, according to Huschke,[3] "rolls on the rounded edge like a pulley." The tendon forms with the axis of the pyramid-shaped muscle an obtuse angle, opening downwards, and passes over to the head of the stapes to be inserted just under the edge of the articular surface of the latter.[3] A few fibres, according to Rüdinger, go to the capsule on the lenticular process of the incus.

The tendon, as the writer himself has seen in the infant at birth, passes in an almost direct line forward from the pyramid to the stapes.

A branch of the facial, passing from the facial canal directly in to the base of the stapedial eminence, furnishes the motor nerve for this muscle.

Regarding the *functions* of the stapedius there is considerable controversy. Some authorities have maintained that the action of this muscle was to draw the stapes *into* the oval window, others *out,* others obliquely, others to turn it on its own axis, at one time therefore an aid, at another an antagonist to the tensor tympani (Henle). In speaking of this muscle, Huschke advances the theory that the stapedius, in drawing backwards the stapes, ought also to make traction upon the descending branch of the incus, thus

[1] Henle, Anatomie, vol. 2, p. 781.
[2] Splanchnologie.
[3] Henle, Anatomie, vol. 2, p. 780.

causing the body of the latter to act on the hammer in such a way as to relax the drum-head, becoming in this manner antagonistic to the M. tensor tympani.

It appears to the writer that the functions of the muscles connected with the transmitting apparatus have been both overrated and underestimated; thus to the tensor tympani has, perhaps, been assigned too much power in maintaining the tension of the mechanism, whilst to the exterior muscles too little has been ascribed.

It would seem that tension was entirely due to the resiliency of the cartilaginous framework of the external auditory canal and auricle, aided by the exterior muscles of the ear, and to the intra-tympanal support mentioned elsewhere.

The intra-tympanic muscles (tensor tympani and stapedius) would appear to have for their function the restoration of tension whenever intra-tympanic air-renewal or other cause forces the drum-head outwardly.

The first-named muscle is actually a continuation of the tensor palati (see p. 48) and when acting in sympathy with it aids in restoring tension by traction made upon the malleus simultaneously with the entrance of air into the drum. Both of these muscles, as is known, receive a nervous filament from the otic ganglion. From his own dissections, and a study of the physiology of the subject, the author is convinced that *the stapedius*, acting at the same time, *aids in this restoration*. This function of the stapedius may be better comprehended from a study of the incudo-stapedial articulation.

The long process of the incus springs out of the body of the bone when *in situ* in a downward and slightly anterior direction, but about midway it begins to curve back again posteriorly and inwardly. The inferior extremity is bent upon the shank at about a right angle, the tip upon which the lenticular process is situated fitting into the cup-shaped cavity of the head of the stapes. This articular surface looks inwardly; its convexity forms with the concave surface of the head of the stapes a ball-and-socket joint, separated by a cartilage somewhat resembling the temporo-maxillary articulation.

Now, when the membrana tympani has, from any cause, been made to move outwardly, the lenticular process glides anteriorly over the meniscus, since the pressure through the malleo-incudal articulation is removed, the incus following the malleus. This movement relaxes the incudo-stapedial articulation. If traction from behind now be made upon the head of the stapes by the action of the stapedius muscle, the lenticular process will be made to glide back again upon the cartilage as a fulcrum, the consequent impingement fixing the

stapes in the oval window. It is probable that tension is also increased by the action transmitted to the shank, causing it to turn slightly upon the axis of its long diameter, and thus aiding in the fixation of the malleo-incudal articulation. Since tension of the transmitting mechanism is partially lost with every sound vibration received and with each act of intra-tympanal air-renewal, and is disturbed also by certain physiological functions, such as respiration, swallowing, and the like, some means is required for its instantaneous restoration: the contraction (reflex?) of the tensor tympani and stapedius would seem to perform this function rather than *maintain tension by constant muscular exertion*.

It affords the writer great satisfaction to find that observations of a similar nature have been recently made by other authors. In a work by Prof. G. Schwalbe, that author makes the following remarks concerning the action of the *tensor tympani*:[1] "Regarding the action of the tensor tympani, I desire to call especial attention to the connection frequently found between it and the tensor veli, and to the innervation of both of these muscles from the same source. It is extremely likely that the contraction of the tensor veli palatini is accompanied by contraction of the tensor tympani. Since contraction of the first opens the tuba, giving rise at the same time to fluctuations of intra-tympanic pressure, it is probable that the importance of the tensor tympani for the membrana tympani lies in the power of the former of regulating the tension of the drum-head to the differences of pressure existing between the air in the external auditory canal and that within the drum."

The connective tissue and mucous membrane composing the sheath of the tendons of these muscles, moreover, give support to the mechanism, and perhaps afford some resistance to outward traction by their rigidity. The delicacy of this mechanism is almost inconceivable when contrasted with muscular action elsewhere, and very slight causes may disturb its equilibrium. Where any defectiveness in the transmitting mechanism exists, even reflex contractions of the muscles themselves may give rise to anomalies of audition.

It should be kept in mind that the exterior or skin muscles are opposed to these interior muscles, inasmuch as they aid in the maintenance of outward tension by their action on the cranial aponeurosis and auricular cartilage. They not only are capable of moving the auricle in certain directions, and of dilating the meatus, but they also, through traction upon the exterior parts, affect the tension of the drum-head.

[1] Lehrbuch der Anatomie des Ohres. Erlangen, 1887, p. 508.

It would seem probable that these groups of intrinsic and extrinsic muscles act automatically, probably through reflex influences, and have an antagonistic relationship towards each other.

3. *M. Laxator tympani major* (Sömmerring), or the *external muscle of the hammer*,[1] fibrous in appearance, takes its origin from the spina angularis of the great wing of the sphenoid, also by fibres from the cartilaginous portion of the Eustachian tube, and from the bucco-pharyngeal aponeurosis, from which triple insertion it passes obliquely outwards and backwards parallel to the fissure of Glaser under which it lies; it then by a small tendon passes into a hole of this fissure and, blending with the anterior aponeurosis of the hammer, is inserted on the neck of the bone above the root of the long or anterior process (Huschke).[2] According to Hyrtl its tendon is inserted on the long process of the hammer, but Henle describes it as being inserted in a fossa on the lateral surface of the head of the hammer. This muscle has been described by Folius, and has since been shown in anatomical manuals and engravings. Its muscular nature has been questioned by numerous authorities, such as Breschet, Arnold, Hagenbach, J. Müller, Lincke, Huschke, and Verga, all of whom regard it as a ligament. Henle[3] says his own careful examinations did not reveal the presence of any striated muscular fibres. Hyrtl,[4] on the contrary, believes in its muscular nature, as do also C. Krause and Moskwin. Treviranus (author of "Erscheinungen"), says Huschke, found the muscle very large in the fox, and placed "in a bony closed cell between the promontory and the head of the hammer; it was composed of muscular fibres starting in rays from a tendon lodged in the middle of the mass." "The tendon was inserted at the end of the long (anterior) process of the hammer, by means of which it acted vertically on the hammer to stretch the drum-head. In the mole it was found to be larger still in proportion, but long and conical. According to Rudolph, it acts with the interior muscle as a tensor to the membrana tympani." Huschke, as already stated, regards the existence of this muscle in man as very doubtful. The writer has himself observed the apparent existence of this muscular structure just mentioned, in the cat, but has never studied its relations or functions. The use of this muscle, according to Sappey, would be to draw the hammer forward and without, consequently *relaxing* the drum-head.

[1] Called also: *Lig. mallei anterius* Arnold; *Lig. mallei tympani* Moskwin; *M. mallei ant.*, s. *Folii*, s. *obliquus* s. *processus minimi mallei* Valsalva, s. *spinoso-mallearis* Schreger.

[2] Splanchnologie.

[3] Anatomie. Vol. 2, p. 777.

[4] Lehrbuch der Anatomie des Menschen. 14th Ed., Wien, 1878, p. 621.

4. *M. Laxator tympani minor* of Sömmerring or of Casserius, called also the *superior muscle of the hammer*,[1] is still more problematical, says Huschke, than the preceding muscle. It is said to start by tendinous fibres from the superior and posterior edge of the external auditory canal above the drum-head, descend within and forwards, and becoming contracted, pass between the lamina of the membrane to be inserted into the external edge of the malleus above its attachment to the tympanum, and also to the short process. Huschke could not discover striated muscular fibres, nor do such authorities as Valsalva, Vieussens, Morgagni, Casselbohm, Meckel, Haller, Treviranus, Hagenbach, J. Müller, Bonnafont, Krause, and Hyrtl[2] recognize its muscular nature. Supposing, says Huschke, that this fibrous band had any action, it would be to pull the handle towards the drum-head, consequently *relaxing* the latter.

Having now considered some of the more important points in the anatomy of the drum itself, it will be well to take up those of the throat, with which the former is intimately connected.

[1] Called also: *M. mallei externus minor*, s. *superior mallei* Wildberg, s. *processus minoris* Valsalva, s. *tympano-mallearis* Schreger; *ligamentum mallei post.*, s. *manubrii* Lincke.

[2] Anatomie, p. 622.

CHAPTER III.

THE RELATIONS OF THE NASO-PHARYNX WITH THE DRUM OF THE EAR AND THE AËRATION OF THE TYMPANUM.

The ear drums, or, more comprehensively speaking, the two middle ear tracts, constitute the superior termini of that ascending portion of the upper air tract which has for its commencement in the naso-pharynx the Eustachian tubes. The Eustachian tubes are the most important of all the connecting channels of the region of the head, affording a passage for the necessary air-supply to the drums, without which their development is defective, and the maintenance of the equilibrium of the transmitting mechanism impossible. These tubes also afford a means of escape for the secretions from the drums to the throat.

The Eustachian tube begins in the naso-pharynx with an oval, trumpet-like mouth; but since the air which traverses it from without is, for the most part, first sucked in through the capacious expansion of the bony and cartilaginous framework constituting the nose, its actual beginning corresponds in capaciousness to its analogous outward expansion on the side of the head, namely, the sound-collecting auricle.[1]

The modus operandi of aërial movements in the upper air tract requires the otologist's special attention in connection with intra-tympanal air-renewal, and since these are inseparably connected with the functions of respiration and deglutition, it will be necessary to present somewhat fully the entire scheme by means of which air reaches the tympanic cavity with such regularity.

Fig. 11, from Gray, shows at a glance the arrangement of the muscles of the palatal region, and which are concerned in regu-

The comparative anatomy of this region of the ear suggests an original adaptation for hearing in an aqueous element, but that the accession of the tympanic membrane to the structure necessitates an aërial equilibrium in which it may oscillate freely when agitated by sound vibrations.

lating the circulation of air in this region. For their description the reader is referred to works on anatomy; reference to their special functions in this connection will be made further on. The pneumatic area in man will be divided for convenience of study here into two systems, namely, the pulmonary and naso-pharyngeal, or lower and upper. These regions may be likened to an elastic rubber air bag di-

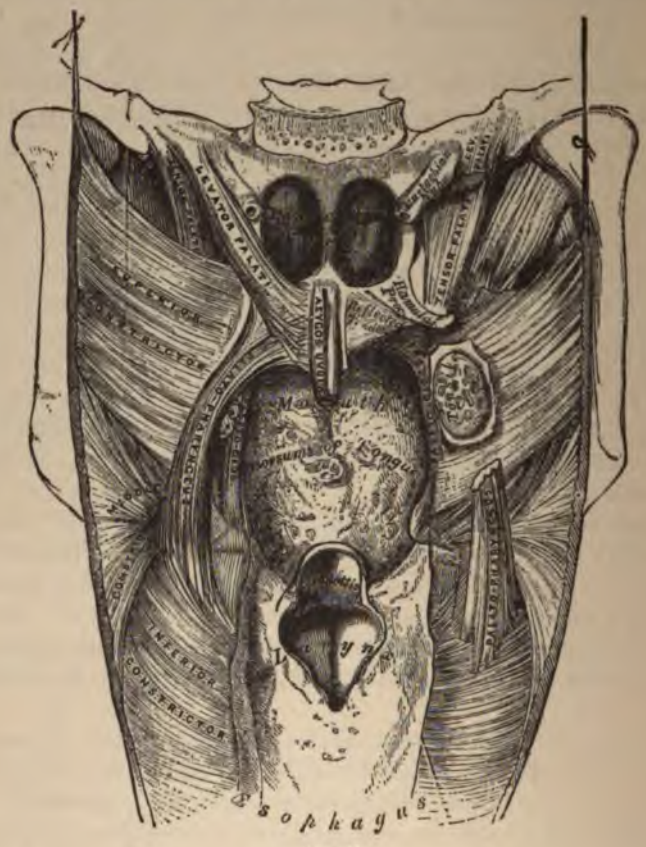


FIG. 11.

vided unequally, as shown in the accompanying diagrammatic illustration (Fig. 12), into a large and small chamber, but communicating with each other by a constricted passage. The air supply of both of these reservoirs is first received into the smaller chamber, mainly through the two nasal passages, air in the normal state in man entering only exceptionally through the mouth, which is adapted more particularly for the reception of food and drink.

As is well known, the pulmonary cavity receives its air supply by means of the suction-force occasioned by descent of the diaphragm and elevation of the thorax ; during this act considerable rarefaction of air in the pharynx and tympanum takes place—the soft palate descending along with the current of air, which, entering the nostrils and then passing down into the lungs, constitutes the act of inspiration. That air is thus withdrawn from the tympanum through rarefaction in the naso-pharynx is proven by the phenomenon which may

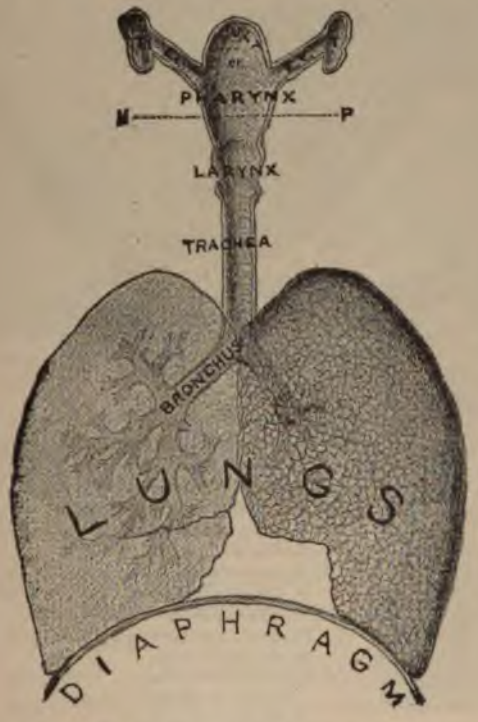


FIG. 12.—DIAGRAM OF THE UPPER AND LOWER RESPIRATORY PASSAGES. (DRAWN FOR THE AUTHOR BY DR. ROBERT BARCLAY.)

H, P, Line showing the level of the hard palate, separating the upper from the lower air tract; T, tympanum, communicating with the pharynx through *E.t*, the Eustachian tube.

be observed in certain cases where the membrana tympani is relaxed, or when a large manometric cicatrix in the drum-head exists ; for under such conditions the membrane is seen to be indrawn with each inspiratory act.

The air remaining in the lesser receptacle (above the soft palate) at the completion of the respiratory act is (on expiration) condensed

by the outgoing current from the lungs, some of it passing along up the Eustachian tube to the tympanic cavity. It would seem that, though the expiratory current passes out of the nose (or mouth) with considerable momentum, that the comparatively slight condensation of air which takes place in the pharynx is sufficient to insure the necessary air renewal of the tympanum. But intra-tympanic air-renewal does not altogether depend upon this method; it also takes

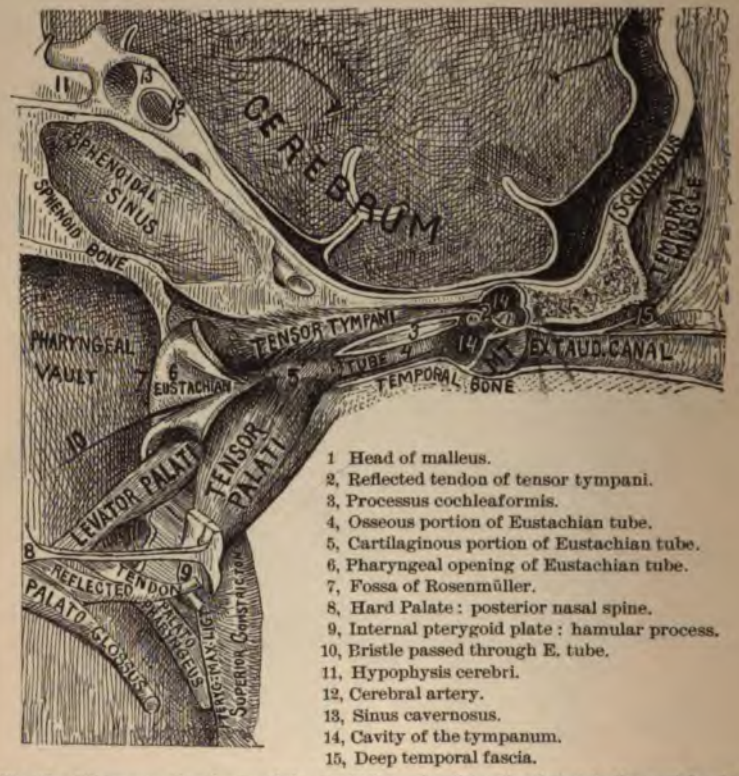


Fig. 13.—Diagrammatic scheme of the conduit passing from the throat to the auricle, showing some of the muscles concerned in maintaining the equilibrium of the transmitting apparatus. Drawn at the author's suggestion by Dr. Robert Barclay.

place during the acts of crying, sobbing, or eructation, when air is expelled from the lungs in an explosive manner, and is sent up into the naso-pharyngeal vault with much energy. In yawning, a free admission of air also occurs, since the action of the pharyngo-palatal muscles then opens the Eustachian tube freely.

Deglutition also most effectively aids in this function. During this act the pharyngeal constrictors come nearly together, while ten-

sor and levator muscles raise and make tense the soft palate, the uvula filling up the slight interval between the constrictors. The swallowing of every particle of food and drink, or accumulations of mucous secretions, gives rise to these phenomena. The walls of the pharynx are not only narrowed laterally, but are also shortened vertically in this way, and the mouth of the Eustachian tube being elevated, more especially by the contraction of the peristaphylinus muscle, is dilated as well as the fibro-cartilaginous part of the tube. There is an upward movement of the fascia of the pharynx during deglutition which can be especially well seen in thin subjects during contraction of the palato-pharyngei. The condensed air in its transit through the Eustachian tube to the ear-drum, it will thus be seen, is much facilitated by the action of the constrictor muscles.

The tensor and levator palati muscles (see Fig. 11, from Gray) are of sufficient importance in this connection to require a more particular description than is usually given, since they, in connection with the tensor tympani, are intimately associated with the performance of the function under consideration.

The *tensor palati*, also known as the *Circumflexus palati, sphenosalpingo-staphylinus, pterystaphylinus externus* (of Riolanus), *peristaphylinus externus* (of Cruveilhier), and *sphenostaphylinus* (of Winslow), is, according to Hyrtl,[1] a flattened muscle which arises from the spina angularis of the sphenoid bone and from the cartilage of the Eustachian tube, passes with a broad tendon around the hamular process of the pterygoid to form conjointly the broad aponeurosis of the soft palate. Acording to Henle,[2] it also has fibres of origin from the neighboring under surface of the temporal wing and from the shallow fossa at the base of the median plate of the pharyngeal wing. Its fibres are "attached in front to the transverse ridge on the horizontal portion of the palate bone" (Gray).[3]

The *levator veli palatini* muscle, or *levator palati*,[4] arises from the under surface of the petrous bone in front of the carotid canal, and also from the cartilage of the Eustachian tube, and sends fibres which blend with the soft palate. The tensor palati is supplied with a nerve from the otic ganglion, the levator palati by a branch from the

[1] Anatomie, page 645.

[2] Anatomie, vol. 2, page 121.

[3] Henry Gray. Anatomy, Descriptive and Surgical. Phila., 1878, page 369.

[4] Also named: Petrosalpingostaphylinus, Petrostaphylinus (Chaussier), Pterygostaphylinus internus (Valsalva), Pterystaphylinus internus (Riolan.), Peristaphylinus internus (Cruveilhier).—See Henle's Handbuch, Vol. 2, p. 123, 1873.

facial, "through the connection of its trunk with the Vidian, by the petrosal nerves" (Gray). The connection between the tensor palati and tensor tympani muscles is also of much significance here, since their fibres are often intimately blended, as may be seen in Fig. 13, and their aponeurotic connection along the Eustachian tube always exists, suggesting possibly that they have no action altogether independently of each other. Although almost invariably described as separate and distinct muscles, they may with advantage be considered together when discussing their functions. Viewed in this manner their action is as follows: During expiration, deglutition, etc., when the palate is elevated by the tensor palati, the membrana tympani is retracted towards the inner wall of the tympanum by the tensor tympani. The effect of contractions of the tensor tympani would be, therefore, to assist in elevating and opening the Eustachian tube for the admission of air and, at the same time, preventing the current from forcing the membrana tympani unduly outwards, and thus interfering with the equilibrium of auditory tension.

Where the transmitting mechanism of the ear is in such an abnormal state that oscillations of the drum-head extend beyond the normal range, the author has often observed that the entrance of air into the drum in excess of its requirements produces cerebral shock. This may be due to excursions of unusual amplitude, inducing shock through impact of the stapes, or to the pressure upon the round window. It thus appears that the constrictor muscles of the pharynx are not concerned in deglutition only, but that they, with the assistance of the palatal muscles, control the movement of air in the upper air-tract.

These interior muscles have a correspondingly close and important relationship to the mucous membrane of the drum, Eustachian tube, and pharynx, through the underlying fascia, that is borne by the exterior muscles dominating the dermic layer and superficial fascia of the outer parts of the ear, as already described. In the combined action of the interior and exterior muscles on the transmitting mechanism of the drum is seen a wonderful adaptation to the production of needed results.

The modus operandi of the mechanism of the ear has long been more or less of a puzzle to physiologists, especially the question of the maintenance of equilibrium. This latter point has enjoyed the attention of no less an authority than Helmholtz, whose studies of the mechanism of the ossicles are of the greatest interest. The suggestion of this author, however, that tension depends on the "tightness" of ligaments further increased by the "elastic tension" of the tensor

tympani muscle, which is very yielding, "yet always slightly stretched" —and "whose tension, besides, is variable and can be adapted to the requirements of the case" [1] —is misleading, since it is a physical impossibility for a muscle to remain constantly in a state of tension. It is true, however, that the ossicles are fixed as described by Helmholtz, the handle of the hammer maintaining the indrawn plane. But the writer is constrained to believe that the auricle and outward parts of the ear, the skin muscles, fascia, etc., are the principal means which keep up the outward tension, and through which, as often as the membrane is driven in by vibratory movements from without, its return to a state of rest is assured.

These conclusions have often been verified by the study of the action of these structures in individuals possessing in an unusual degree voluntary control over them, as may be seen in the instances to be presently cited. And further confirmation is to be found in observations in cases where disease has left the drum-head in that abnormal state known as *manometric, i. e.*, where a cure has been effected in perforative inflammation through closure by a reproduction of the dermic layer only, which is much thinner and far more distensible than normal membrane. Examples of these will also be given.

The following are examples of remarkable voluntary control of the pharyngo-palatal muscles :

Case 1.—Master A., 14 years of age, came to the author on account of a catarrhal condition of the upper air-passages which involved the ear-drums, but had given rise as yet to only a very slight amount of deafness. He is of slender build, tall for his age, and the muscular movements generally are very free, especially those connected with the ear. *By a slight voluntary effort he can contract the tensor palati and tensor tympani muscles.* The ability to thus bring these muscles into action, a function usually involuntarily performed along with the pharyngeal constrictors only, was discovered quite accidentally. When he produced a humming noise with the mouth closed, he discovered that the effort involved the palato-pharyngeal muscles in such a way that the humming was very loud as heard by himself, and he was surprised on practising in this way in the school-room that the noise was not observed by others. When this curious experiment was made out of doors, street sounds seemed distant and muffled. He was amused very much to thus experience deafness one moment and the next to hear the loud clatter and roar of street sounds, as he alternately contracted and relaxed the muscles dominating the tension of the drum-heads from within. The autophonous phenomena lasted while he kept up the contractions, and besides his own voice,

[1] The Mechanism of the Ossicles and Membrana Tympani. Prof. Helmholtz. Trans. by James Hinton. The New Sydenham Society. London, 1874, pp. 121, 122, 130.

respiratory sounds and the rushing and gurgling of the blood in the neighboring arteries could be heard. A gentle murmur "like a sea shell" was also distinguishable. Rhinoscopic inspection showed that the entire integumentary wall of the pharynx was, with great facility, carried upward by the underlying fascia during the performance, dropping down again when relaxation occurred. The contractions could be made with great rapidity—as frequently, in fact, as once every second, but more slowly if it was desired. The exercise tired the patient finally if long continued, and subsequent trials required greater effort. The patient could never learn to hawk. By means of the diagnostic tube connecting their ears, the writer could distinctly hear a soft click or thud in the tympanum of the patient whenever the contractions took place. The act of gaping during these contractions increased the tension very much and all of the subjective phenomena were more pronounced. He has possessed this curious faculty for a long time, and practice has made it much more easy of execution. The patient's father, a medical man, has also the power of voluntarily moving these muscles in an unusual degree, and during the act much roaring in the ears is experienced.

The author finds upon his records many cases similar to the foregoing, one of which has been already given (Case 3, p. 33); though space is wanting for others it is believed that the above are sufficiently illustrative of the point in view. The study of the performance of the function of intra-tympanic air-renewal from a pathological point of view seems also to confirm the views advanced. Many opportunities for this present themselves where the transmitting mechanism has lost its tension from disease. The very frequent presence of manometric cicatrices of the drum-head greatly facilitates observations in this direction, and the anomaly, moreover, when carefully sought, will be more frequently found than many suppose, since the drum-head in destructive suppurative processes is liable to undergo reparation in this manner.

The following cases have been selected:

CASE 2.—Patient, male, 60 years of age, is the subject of long-standing catarrhal inflammation of the middle ears, the drum-heads showing extensive nutritive changes. He has constant tinnitus in the ears like singing, and when gaping this changes to a sound resembling the ringing of a bell of high pitch, especially in the left ear. A similar experience occurs if the left auricle is smartly tapped with the fingers. When the cartilaginous canal of the left ear is pushed inward the voice is autophonous.

CASE 3.—Male, 28 years of age. The drum-heads have a humid appearance, due to chronic catarrhal inflammation; the left is greatly relaxed, and, on Valsalvan experiment being made, becomes very convex. For twelve years he has experienced autophonia in this ear. At first, tightly stopping the meatus with a wad of cotton-wool over

night would often prevent recurrence of this phenomenon the following day, but of late this has failed to be of any service. Hearing the transmitted heart pulsations autophonously has given him much anxiety, and this has been the cause of treatment directed to supposed cardiac disease. Autophonia ceases while the tensor palati and tensor tympani muscles are in a state of voluntary contraction, and when the patient assumes a horizontal position.

CASE 4.—Male, 38 years of age. Has chronic catarrhal inflammation of the drums, with decided trophic changes in both membranes. He is subject to autophonia which gives rise to great distress during the act of swallowing food, when it is much increased. With each act of mastication there is an oscillation of the drum membranes, giving rise to a sensation resembling the metallic vibration produced by springing in and out the bottom of a tin pail. Blowing the nose forces out the drum-head and "stops up the ears."

CASE 5.—Female, 33 years of age. Has manometric cicatrices. She has the power of contracting voluntarily the tensor palati and tensor tympani muscles and thus improving hearing. Traction upon the auricle has the same effect, *i. e.*, restores auditory tension. In this case tension in either direction seems to restore equilibrium.

CASE 6.—Male, 63 years of age. Has chronic catarrhal inflammation of the middle ears with relaxed membranes. Patient suffers from autophonia with a constant sensation of "thickness" in the ears, which is relieved by eructations. Rather prolonged Valsalvan efforts, however, increase the unpleasant symptoms for a time. Inflation with the air-bag causes the explosive sound, and increases temporarily the deafness. Traction upon the auricle improves hearing.

CASE 7.—Female, 22 years of age. She can voluntarily produce movements of the auricle, the action being accompanied by a sense of something moving "inside her face." She can also voluntarily contract the tensor palati and tensor tympani muscles, and during the act all extraneous sounds seem to come from a distance, and a "vacuum" or feeling of "numbness" is felt about the ears. It will be observed that the effect of the tension thus made upon the membrana tympani was to "damp" or "muffle" the transmitting mechanism.

CASE 8.—Male, 26 years of age. Has chronic catarrhal inflammation of the middle ear with a large manometric cicatrix in the right membrana tympani. The latter is bulged out on swallowing or on performing the Valsalvan experiment, giving rise to autophonia. Patient possesses the power to voluntarily retract the membrana tympani by means of the intrinsic tensor muscles, on which the autophonia disappears.

CASE 9.—Male, 20 years old, with chronic catarrhal inflammation of the drums. The membranes are humid in appearance and have manometric cicatrices. Swallowing and the Valsalvan experiment

cause crackling sounds in the left ear. He experiences autophonia much of the time, during which all extraneous sounds heard seem to be "muffled," and his own voice, on entering the ear from within, appears to be projected "against a cloth." He can nearly always relieve the autophonia by traction on the tragus. The "clouded" feeling, always existing in the ears, causes him to perform the act of swallowing or yawning very frequently. During the act of swallowing, if the otoscopic tube be employed, the soft gliding motion of the tensor tympani muscle can be heard, and if the Valsalvan experiment is done, the membrana tympani can be heard to bulge outwardly with a "thud."

CASE 10.—Female, 24 years of age. Has manometric cicatrices of both membranes. Hears only loudest voice in one ear and loud in the other. Hearing improves very much after blowing the nose, or by making traction on the auricle with a finger placed in the concha. After Valsalvan experiment, the drum-heads are heard to return to their usual position with a "snap."

CASE 11.—Male, 21 years of age. Both membranes have manometric cicatrices, due to ear-boxing, on both sides. Hearing is very good unless autophonia exists; the frequent recurrence of ths phenomenon, however, gives rise to variable hearing, and when aural catarrh is present, this is more marked. Usually the distress is easily relieved by slight voluntary contraction of the tensor palati and tensor tympani muscles, pulling the auricle outwardly or moving the jaws as in mastication. Valsalvan experiment bulges out the membranæ and increases the trouble.

A study of the above phenomena occurring in advanced stages of chronic catarrhal inflammation of the middle ear, attended with atrophy of the mucous lining, and perhaps other changes, together with a relaxed drum-head and deafness, will be found, it is hoped, exceedingly instructive in this connection. In looking over the notes of a large number of these cases, the writer finds numerous other examples, among which the following are more important:

In a number of instances the recurrence of head catarrh, accompanied by increased mucous secretion, improved hearing very much while the exacerbation continued; and in many instances "crackling" or "cracking," or "stopping up with air bubbles," or "shutting up," or "closing the ear" occurred on swallowing, sneezing, yawning, hiccoughing, or moving the jaw as in mastication; in all of them there was an increase of deafness for a longer or shorter period of time. On the other hand, an equally large number of patients found that the very same phenomena caused better hearing temporarily. These experiences are a constant source of great annoyance to the patient when eating or conversing. In one case, where there was a perforation of the left drum-head, during the first act of swal-

wing, the "ear was closed to hearing," but the second act "cleared it up again."

A very interesting case was one where the drum-heads were much relaxed, and the Valsalvan experiment, or swallowing, bulged them out; on yawning, the left membrane was first bulged outwardly, "opening" the ear, and retraction or collapse immediately following, "closed" the ear to hearing. The interference with tension of the transmitting mechanism which tunnel-workers under high atmo spheric pressure often experience, is a practical illustration of the importance of keeping in mind the conditions under which auditory equilibrium is maintained, and even in mild catarrhal attacks of the upper air-tract, closure of the Eustachian tube to a slight extent only is very often sufficient to interfere with the performance of the functions of these parts. The writer has frequently observed that persons having defective ear-drums acquire, almost unconsciously, the habit of adjusting auditory tension by resorting to some of the expedients mentioned above. Equilibrium may thus be established by tractile force applied from without, as by movements of the inferior maxillary, which affect tension by pressure of the partially displaced coronoid process upon the cartilaginous portion of the external auditory canal; or by traction upon some portion of the auricle. On the other hand, the desired result is brought about by muscular force exerted from the pharynx, as in snuffing in air, swallowing, sighing, yawning, and the like.

CHAPTER IV.

THE SENSE OF HEARING.

The perception of sound, which constitutes audition in man and the higher forms of air-breathing animals, is similar to the sense of touch which seems to be the only medium of hearing in some of the lower forms of life. Impulses of air, indeed, may be perceived by man when received upon the cutaneous surface, specially the shock from the discharge of great guns and other violent explosions if near. Advantage is taken of this fact in communicating with the deaf, a remarkable instance of which was related to the writer by Prof. A. Graham Bell: the case being that of his mother who is deaf to ordinary conversation, but takes cognizance of sound when Prof. Bell places his lips in contact with one of her eyes while speaking. A similar instance to the above was reported many years ago in the *American Journal of Medical Sciences* by the late Prof. Muzzy, where a deaf boy could apparently hear best through the back part of the head.

The highly specialized function of hearing in man requires for its performance the oscillating expansion of the skin, known as the drum-head, which vibrates free in equilibrio when agitated. The performance of the function of hearing consists (1) in the collection of sound by the auricle and external auditory canal; (2) its transmission by the conductive mechanism to the middle ear to (3) the nervous apparatus of the inner ear, and finally its impression upon (4) the perceptive centre of the brain.

The perception of sound. Since the phonograph of Edison and the telephone of Bell have made familiar the behavior of sound in its relations to the ear, so far as actual transmission to the inner ear is concerned, the field of speculation now seems mainly limited to the functions of the nervous apparatus.

Hearing takes place through the motion imparted to the auditory apparatus by the movements of sound. Excursive movements of the drum-head having been first induced, the impulses of sound are trans-

mitted through the chain of ossicles —the malleus, incus, and stapes— to the inner ear, giving rise to aqueous vibrations in the semicircular canals and the superior scala (or scali vestibuli) of the cochlea. The membrana tympani secundaria (or membrana fenestræ rotundæ), responding to vibrations which are unimpeded by the drum-head, communicates them to the fluid inclosed in the inferior scala (or scala tympani) of the cochlea. The several branches of the auditory nerve are thus simultaneously influenced by the various sounds of which the perceptive centre is capable of taking cognizance.

The terminal filaments of the nerve of hearing distributed in the inner ear possess the function of taking up the sounds transmitted from without, their tension being adapted to receiving and transmitting impressions of which sound is composed. If it be permitted to thus briefly formulate a hypothesis of the modus operandi of a nervous apparatus, apparently so complicated when viewed in the light of existing knowledge, in lieu of other conjectures (since an exhaustive review of the subject would be out of place here), this inference may be made : that the different surfaces of the sentient region of the scalæ of the cochlea and of the semicircular canals, when influenced (excited) by sounds of various pitch and loudness, are adapted to imparting (transmitting) them to the perceptive centre. That the auditory nerve possesses the seemingly complex function of transmitting a large number of sound impressions received from without at the same moment may be inferred from an understanding of analogous and demonstrable phenomena in physics, as, for example, the electrical transmission of multiple messages simultaneously through a single wire, or the well-known action of the transmission in telephonic communications of speech. By the latter it is proven that all tones, however complex, are transmissible without any so-called nervous analysis ; and by means of the phonograph they may even be permanently impressed upon a metallic surface to be given off again without change in the form of sound vibrations.

The writer has long been of the belief that the accepted theories of audition, in respect to certain important anatomical and physiological dogmas as set forth with such distinguished ability by Hemholtz, and to which allusion has been above made, are faulty, and the views thus held for the past ten or twelve years, and set forth in publications from time to time, especially in a paper prepared for the American Otological Society,[1] have gained strength from subsequent observations. Other writers have also begun to express doubts in respect to the soundness of the generally accepted views on this sub-

[1] Trans. American Otological Society, 1878.

ject, and those of Prof. Rutherford,[1] given in a lecture delivered before the British Association, are so much to the point that his conclusions are here quoted at length.

He pays this tribute to Helmholtz which the present writer fully indorses :

"This theory of sound-sensation, then, is so full of difficulty when applied to the peripheral mechanism in the ear, and so unsatisfactory when we pursue it into the brain, and it seems so hopeless to adapt it to the facts, that I think it must be abandoned. But before I propose another theory, I would pay a humble but sincere tribute to the genius of Helmholtz. His magnificent services to science have long since placed his name amongst those of the immortals. His theory of sound-sensation may be faulty, but that can never tarnish the splendor of his many wonderful contributions to the progress of scientific knowledge."

In referring to the sense of hearing Prof. R. says :

"Some five years ago it struck me that the case of the telephone may throw light on these difficulties regarding the sense of hearing. In the telephone there is a thin plate of iron placed near the end of a permanent steel magnet. A bobbin of thin copper wire is coiled round the end of the magnet nearest the plate, and is connected with a bobbin of wire around the magnet of a second telephone in every respect similar to the first. When sound-waves fall on the plate of the transmitting telephone it vibrates. The vibrations of the iron near the magnet affect the magnetism, and so induce in the wire currents of electricity whose frequency and amplitude correspond to those of the vibrations of the iron plate induced by the sound. The currents travel to the receiving telephone and induce oscillations of its magnetism, which in turn cause its iron plate to vibrate and produce sounds similar to those communicated to the first telephone. There is no analysis of the sound-waves. The transmitting telephone takes up simple or complex vibrations. The harmonies of an orchestra may fall upon it, and it does not fail to convert the complex sound-vibrations into electrical vibrations, and these again into the complex sound of the orchestra in the receiving telephone. It is, indeed, one of the most wonderful inventions of recent times. Can it throw light on the sense of hearing ?

"The theory which I have to propose may be termed the Telephone Theory of the Sense of Hearing. The theory is that the cochlea does not act on the principle of sympathetic vibration, but that the

[1] A Lecture on the Sense of Hearing. William Rutherford. The Lancet, January 1st, 1887.

hairs of all its auditory cells vibrate to every tone, just as the drum of the ear does; that there is no analysis of complex vibrations in the cochlea or elsewhere in the peripheral mechanism of the ear; that the hair cells transform sound-vibrations into nerve-vibrations similar in frequency and amplitude to the sound-vibrations; that simple and complex vibrations of nerve-molecules arrive in the sensory cells of the brain, and there produce, not sound again of course, but the sensations of sound, the nature of which depends not upon the stimulation of different sensory cells, but on the frequency, amplitude, and form of the vibrations coming into the cells, probably through all the fibres of the auditory nerve. On such a theory the physical cause of harmony and discord is carried into the brain, and the mathematical principles of acoustics find an entrance into the obscure region of consciousness. Now if nerve energy were only electricity, that theory would probably be accepted at once. But nerve motion is very sluggish when compared with electricity.

"I have kept this theory back for five years, because I felt I had no evidence of the possibility of sending a rapid succession of vibrations along a nerve. It cost me a good deal of thought and experimental observation to find the evidence I required. If we give to a motor nerve of a frog or rabbit 10 instantaneous shocks of induced electricity in a second, 10 impulses will pass along the nerve to the muscle, and produce 10 distinct contractions in the same period. If we send 40 impulses along the nerve, we get, not 40 contractions of the muscle, but a single continuous contraction, because the several contractions are fused together. Now, if we listen to the muscle so stimulated, we hear a musical note having the pitch of 40 vibrations per second. Each sound-vibration results from the sudden shock of chemical discharge due to the arrival of each nerve impulse in the muscular substance. If we stimulate the nerve, say, 200 times per second, by causing a tuning-fork to make and break the primary circuit of an induction machine, and so send 200 shocks per second into the nerve, the pitch of the note in the muscle exactly corresponds. It has the same pitch as the fork. I experimented in this way, and eventually found that I could send as many as 352 impulses per second along the nerve of a rabbit and get a note from the muscle of the pitch of 352 vibrations per second—that is, a note of the pitch of F in the lowest space of the treble clef. But when I tried by more rapid stimulation of the nerve to get a higher note from the muscle, I failed; there was nothing but a noise heard. That a low rumbling sound is produced by a contracting muscle is known to every physiologist. You can hear it if you firmly clench the jaws

during the stillness of night, when other sounds are hushed. It is a sound of very low pitch due to vibrations certainly below forty—perhaps not more than ten or twelve per second. There is, therefore, nothing new in my statement that a note may be heard in a muscle; the new point is that the pitch of the note may be increased by a more rapid stimulation of the nerve, and that as many as 352 impulses may be sent along a nerve and retain their individuality so sharply that they can produce a note in a muscle having a pitch number of 352. That fact will give support to a vibrational theory of nerve energy.

"Now, am I to conclude that, because I failed to get a higher note than one of 352 vibrations from the muscle, it is not possible to send more than 352 vibrations per second along a nerve? By no means; the fibres of a muscle are very different from those of a nerve, and also very different from nerve cells. The molecules in both of them can probably vibrate far more rapidly than 352 times per second.

"I have therefore directly proved that vibrations of the same frequency as all the lower tones of the scale, from the lower F of the treble clef downwards, can be transmitted by a nerve. A short time ago it occurred to me that the note produced by the wing of an insect furnishes a simpler proof of the possibility of transmitting a rapid series of impulses along a nerve. The wing of the humble-bee produces the note F in the lowest space of the treble clef. It gives, therefore, 352 complete vibrations in a second. Every downward motion of the wing doubtless results from an impulse sent along the nerve to the muscles that lowers the wing. Therefore we may conclude that about 352 impulses per second traverse the motor nerves of the humble-bee's wing during flight. In the honey-bee the note of the wing is A in the treble clef—that is, two notes higher than in the humble-bee, so that 460 impulses appear to pass along its motor nerves in a second. In a human motor nerve the impulses transmitted by it during voluntary effort are not more than 10 or 12 per second (Schaefer). I have therefore some substantial evidence in support of my theory of sound-sensation. And I cannot but think that the evidence in favor of it will increase. I do not wish you to suppose that on my theory of hearing difficulties disappear; far from it. I merely assert that the difficulties which seem insurmountable on the theory of Helmholtz are diminished by the theory which I have submitted. Should my theory of the sense of hearing find acceptance, it will lead to a reconstitution of theories regarding the other sense organs."

PART SECOND.

CAUSES OF EAR DISEASE.

CHAPTER V.

Heredity. Cachexia. Age. Occupation. Defective Personal Hygiene. Syphilis. Acute Infectious Diseases: Scarlet Fever, Measles, Variola, Diphtheria, Cerebro-spinal Meningitis, Mumps, Pertussis, Typhoid, "Roman," and other Fevers. Cutaneous Affections.

It is a trite, but nevertheless important saying, that violations of the laws of health are transmitted to the offender's offspring, and, in considering the causation of diseases of the upper air-tract, heredity must be taken into account, as well as in every disease to which man is subject.

Of course, the more important and more frequently met with causative influences only can be considered here, and space will not admit of an extended notice of these.

HEREDITY, CACHEXIA, ETC.

Various transmitted constitutional taints, such as arise from consumption, syphilis, gout, etc., interfering with the development of the individual, and also the physical deterioration found in the offspring of intemperate and dystrophic persons, should be considered causative, more or less, of many aural troubles. Besides the physical defects due to arrest of development in the ears, eyes, teeth, and other organs, and, furthermore, the disease of the glandular structures (strumous habit) among such progeny, they are liable to be exceedingly neuropathic and susceptible to the invasion of disease.

The records of the author also show a large number of instances where ear disease was disclosed in both of the parents and some or all of the children. In one family, the mother, eight of her children, and an aunt were suffering at the same time with purulent catarrh of the middle ear; in another, both parents and five of their children were likewise affected with some form of aural catarrh. To find three or four children in the same family affected in this manner is quite a common occurrence.

The possible effect of influences on the maternal progenitor are

worthy of consideration. The following case in this connection is suggestive: The first-born child of a healthy, well-developed, and intelligent woman was, when six months of age, thought to be deaf, since she could only hear jarring of the floor and the like, and the sound of a high-pitched whistle which her father carried, and which seemed to become quite familiar to her ears. The mother had, however, during the first month of pregnancy an attack of rubeola, and was, furthermore, much worried during the entire period of gestation about her husband, who was very nervous and becoming deaf from aural catarrh. When the writer examined this child at the age of sixteen months, it was found to have catarrh of the head and ears, the origin of which may have been embryonic. No anatomical malformation of the ears was discovered in the infant, nor was there any apparent transmissible organic defect in the parents.

AGE.

To judge from the considerable number of deaf-mutes seen where no congenital deformity can be detected, the occurrence of prenatal catarrh is probably very frequent. A dysthetic condition of the fœtus giving rise to the development of head-catarrh may thus arise from syphilitic taint or other constitutional cachexia in the parents. The fœtus is likewise affected by other influences, among which the exanthemata deserve especially to be mentioned. Whether the early development of the deciduous teeth is ever active enough to cause disturbance will require considerable research to determine; but reflected irritation from this source might occur, it would seem, since there are instances of their presence at birth, or very early appearance after this. Protracted labor is liable to be attended with injury to the ear, as Von Troeltsch has so well pointed out in his admirable work on "Diseases of the Ear in Children."

Purulent catarrh of the middle ear with profuse discharge is very much more frequent in infancy and youth, while atrophic catarrh is largely a disease of adult and middle life. As the adult subject advances in life, the effects of dystrophia naturally manifest themselves as progressive aural catarrh, and the resulting defectiveness in the transmitting mechanism of the middle ear gives rise to forms of ear disease, with great deafness.

OCCUPATION.

The occupations and habits of people have much to do with the production of various aural complaints. Those exposed in their work

to atmospheric changes, to damp and chilly, likewise to overheated air, in dusty and dirty shops, are much more prone to ear disease, than those persons working in better and more healthy surroundings. Among the first should be mentioned the tunnel-workers and the drivers, both of whom are constantly subjected to great atmospheric pressure (see Chapter XIX.). The class of laborers who are constantly exposed to loud, sudden, and continued noises, as, for instance, boiler makers, engineers on railroads, and workmen employed in noisy factories, are all liable to experience trouble in the ears from the irritation of constant aërial impact (see Chapter X.). Longshoremen, dock-builders, miners, night watchmen, etc., are especially liable to ear affections due to out-door vicissitudes. The class of individuals, furthermore, which includes the workers in tobacco, tea, and coffee, the shop girls and clerks overworked in badly ventilated shops, telegraph operators, governesses, waiters, etc., are exposed to over-heating and dust, and will be found to suffer from catarrh of the upper air-passages, rendering them very susceptible to ear diseases.

DEFECTIVE PERSONAL HYGIENE.

The hygienic feature of the treatment of disease is too important to be entirely passed over in silence in a work devoted to even a special department in medicine. The normal state of man in this connection may be regarded as one in which he can best adapt himself to the vicissitudes of out-door life in any climate in which he may chance to live. His health demands that the usual exercise taken must not be beyond the verge of moderate fatigue, nor omitted altogether in either very warm or very cold weather. Since animal heat is derived from food, the latter must be proportioned to the quantity of the former lost through escape into space by radiation, which is greater in cold than in warm weather.

The problem of maintaining an equilibrium where thermal variation is great is one of difficult solution, especially in winter weather; thus exercise is impeded, in a measure, proportionately to the means employed in retaining bodily heat by means of clothing, etc. If the escape of heat from the body by insensible perspiration is prevented, in addition to the use of non-conducting clothing, by impervious rubber cloth, the skins of fur-bearing animals, and the like, which interfere with evaporation, the clothing becomes saturated with moisture, an exceedingly unhealthful and disagreeable condition. The injudicious use of rubber cloth and fur garments in our temperate

climate is therefore greatly to be deplored. The seductive comfort of the sealskin sacque has made this mantle of death a favorite even more than its handsome appearance, and its constant use, as well as that of fur collars, fur trimmings, and boas about the neck, is the cause of not only severe pulmonary disease, but of head-colds ending in persistent aural and nasal catarrhs.

These ill-effects are due to the greatly increased sensibility which ensues from the use of such clothing, often combined with neglect of out-door exercise, and over-feeding. In the writer's experience, children are often made exceedingly susceptible to colds by the use of superabundant, though handsome, wraps made of furs, which in our climate are at best suitable only for emergencies arising in exceptionally cold weather.

Space will not permit of extended observation on this topic, but, in conclusion, the writer would caution against attributing bodily troubles to exterior influences alone, since nervous strain, improper feeding and the like, are no less frequently to blame than the forme.

SYPHILIS.

Affections of the organ of hearing in the primary stage of syphilitic infection are very rare. There have been, however, some few cases of chancre of the auricle and neighboring parts reported by different authors. It is in the secondary stage that aural affections are most frequently met with, and of these latter the rapidly increasing or sudden deafness with more or less distressing tinnitus aurium form he prominent symptoms. The reader may consult Chapter XII. for further information on this subject.

ACUTE INFECTIOUS DISEASES.

Scarlet Fever. Measles. Variola. Diphtheria. Cerebro-spinal Meningitis. Mumps. Pertussis. Typhoid Fever. "Roman," and other Fevers.

The exanthemata form by far the most important among the above-named group of diseases, all of which tend so much to the production of ear troubles, and of which scarlet fever should be regarded as the most prominent.

The ear becomes affected in *scarlet fever* by immediate invasion of the mucous membrane of this organ, along with the rest of the upper air tract. A poisoned condition of the blood (uræmia, pyæmia, etc.) occurring in some cases may also be regarded as remotely causative. The frequency of aural disease resulting from scarlatina cannot be

estimated with accuracy, since many cases attributed to this cause by parents are found on inquiry to have some other origin. Burckhardt-Merian [1] tabulated four thousand three hundred and nine cases of acquired deaf-mutism, four hundred and forty-five (or 10.32 per cent) of which were alleged to have resulted from scarlet fever.

The symptoms of acute catarrhal inflammation of the middle ear, occurring during the course of a severe attack of scarlet fever, are liable to be overlooked, owing to the gravity of other manifestations of the disease, and any aural trouble becoming quiescent on recovery may not be discovered until roused into activity by some other cause.

Scarlet fever may be followed by mastoid disease, caries of the temporal bone and of the cervical vertebræ, retro-pharyngeal abscess, etc.; all consequent to purulent otitis media. A case of this kind was reported by Gundrum [2] in 1882.

Such dangerous complications result sometimes in hemiplegia and facial paralysis. Among the sequelæ of scarlet fever should be mentioned an offensive discharge from the external meatus with eczematous inflammation and swelling of the cervical glands, ending often in suppuration.

The author has selected from his records 103 cases out of a large number seen of ear disease said to have followed an attack of scarlet fever, as illustrative in this connection. Of these, 61 were females and 42 males. The aural diseases for which these patients presented themselves for treatment were as follows:

Acute purulent otitis media in 4 cases.

Chronic purulent otitis media in 81 cases.

Chronic catarrhal otitis media in 24 cases.

Three of these patients were deaf-mutes (2 males and 1 female), and the deafness was very marked in 9 cases.

The large majority of these cases were children, and in the cases of adults the ear disease had mostly existed since childhood.

Measles are of scarcely less importance as a factor in the production of aural diseases, the latter developing in about the same manner as in scarlet fever. The angina of both measles and scarlet fever has a special tendency to extend by continuity of surface into the nasal passages and into the Eustachian tubes; permanent impairment of hearing, in consequence of adhesions, rigidity, and destruction even, of parts of the transmitting mechanism is too often a result (Spen-

[1] Ueber den Scharlach in seinen Beziehungen zum Gehoerorgan. Volkmann's Sammlung klin. Vortraege, No. 182.

[2] A case of chronic Otorrhœa following Scarlatina. Medical News, Aug. 26th, 1882.

cer).[1] In measles, as in scarlet fever, there is a type of aural complication beside the one which corresponds to the acute catarrhal inflammations which follow catarrh of the upper air tract, namely, that originating primarily in the drum-head and accompanying the appearance of the cutaneous eruption on the face.

The author selected from his records 73 cases of aural disease said to have resulted from measles, of which 44 were females and 29 were males. The aural diseases of these patients were as follows:

Otitis media purulenta chronica was present in 47 cases.
Otitis media purulenta acuta was present in 10 cases.
Otitis media purulenta subacuta was present in 2 cases.
Otitis media catarrhalis chronica was present in 14 cases.
Otitis media catarrhalis acuta was present in 6 cases.
Eczema was present in 4 cases.

Symptoms of deafness, otalgia, autophony were present in many of these cases.

In the exanthemata, discharge from the ear often escapes observation until the patient is in the desquamative stage, and the more important general symptoms have passed. But aural complications, which usually begin along with the severe throat manifestations or when the mucous surface is at the height of inflammation, may occur at any time.

A tabulated report of the Belgian Government, in 1847, shows that of 1,892 cases of acquired deaf-mutism from all causes, 216 were from scarlatina, 80 from measles, and 28 from small-pox. Of 86 cases (American) of non-congenital mutism, 41 were from scarlatina. Wilde, 1853, reported that of 394 cases of acquired deaf-mutism, 35 cases followed scarlatina, 12 small-pox, and 7 measles (Spencer).[2]

Diphtheria.—Diphtheritic inflammation of the middle ear in scarlet fever has been reported by some authorities as very common (Wreden). The diphtheritic process extends via the Eustachian tubes into the middle ear, involving in some cases even the labyrinth. The stage in which such patients usually presented themselves for treatment was about two weeks subsequent to the commencement of the exudation, when suppuration had been established (Gottstein).[3]

The author's records show that of 12 cases of aural disease claimed

[1] The Ear in the Exanthemata. Trans. of the Medical Association of the State of Missouri, 1878.

[2] Ibid.

[3] Beitraege zu den im Verlauf der acuten Exantheme auftretenden Gehōraffectionen. Arch. für Ohrenheilkunde, xvii., 1, 2.

to have occurred after diphtheria, 11 were females and 1 male Chronic purulent otitis media was present six times, and the acute form once; chronic catarrhal otitis media was also present once, and two cases were suffering from severe otalgia.

Variola.—In small-pox the mucous membrane of the pharynx and nares is not so constantly, but is commonly, implicated, being affected by inflammation in one form or other (Spencer).[1]

Wendt[2] dissected the ears of 168 persons who died from variola (both vera and hemorrhagica), arriving at the following conclusions: That hyperæmia of the mucous membrane of the middle ear has little or no influence on the hearing, etc., and that, furthermore, variolous processes proper heal without injurious effect on the ear, since he has never found stricture, contraction, or obliteration in the tube as the result of that process. Grindon[3] reports 6 cases of otitis media purulenta, occurring as a complication, out of 310 cases of variola. It was present 4 times among 124 confluent cases, circa 3¼ per cent. In 2 of these cases it followed parotiditis. Among 43 cases of discrete variola and 36 of the hemorrhagic type, there was not a single case of this complication; those of the last-mentioned class all dying before the sequelæ appeared. Among 107 cases of varioloid, otitis media purulenta occurred twice, and in one of these it followed an attack of facial erysipelas. All 6 cases were males.

The author reports 4 cases coming under his observation. Three of these patients were females. One patient applied for treatment for chronic purulent otitis media in one ear and chronic catarrhal otitis media in the other, the deafness being very great. Two of the patients had ulceration of the external auditory canal, together with chronic purulent otitis media. Chronic catarrh of the middle-ear tract, followed by great impairment of hearing, was the sequel of variola in the only male patient.

Suppurative otitis media is said to occur sometimes after vaccination, and Spencer[4] and W. A. Bartlett[5] have both reported cases of this kind. In the opinion of the author, however, further investigation will in most, if not in all, cases show that the aural disease has been falsely attributed, by parents, to contamination of the vaccine virus.

[1] Op. cit.

[2] Ueber das Verhalten des Gehörorgans bei Variola. Arch. der Heilkunde, 1872.

[3] Otitis Media as a Sequel of Small-pox. St. Louis Courier of Medicine, August, 1882.

[4] St. Louis Courier of Medicine, May, 1882.

[5] New York Medical Journal, September 13th, 1884.

This, at least, has been his experience in those cases coming under his own observation.

Cerebro-spinal meningitis is known as a frequent cause of deafness and deaf-mutism in children. Complete and bilateral loss of hearing is the most usual aural complication arising from this disease, although, according to J. Lewis Smith,[1] a mild grade of otitis media, subsiding without impairment of hearing, is common. The loss of hearing appears to take place in some cases during convalescence from the fever, but the patients are mostly observed to be deaf when full consciousness returns. Some authors are of the opinion that deafness following an attack of cerebro-spinal meningitis is an exception. It must be admitted, however, that numerous cases of alleged cerebro-spinal meningitis in infants are undoubtedly cases of acute otitis media. Of a number of cases observed by Smith in the epidemic of 1872, about one in every ten patients became deaf. Only one case of the ten coming under his observation was an adult, the others being all under ten years of age. Knapp examined 31 cases, in all of which deafness was complete, with two exceptions, and in all bilateral. That many deaf-mutes owe the origin of their condition to an attack of cerebro-spinal meningitis in their infancy has been definitely settled. In his elaborate "Memoir upon the Formation of a Deaf Variety of the Human Race," Bell has shown by the statistical reports of two deaf and dumb asylums, that the increase in the number of deaf-mutes in those institutions after the prevalence of epidemics of cerebro-spinal meningitis was very remarkable; especially those of 1810–1819, and 1860–1869. Deafness was observed by Upham,[2] among the prominent symptoms at one time or other, in twenty-one cases out of three hundred and fifteen cases of cerebro-spinal meningitis. Concerning the origin of this deafness; it may depend on an inflammatory lesion at the acoustic centre in the brain or in the course of the nerves of hearing to the auditory foramina (according to Stillé, through pressure of plastic exudation surrounding the nerves). There may also be an inflammatory state of the labyrinth. Heller and Lucae both found evidences of labyrinthine disease in post-mortem examinations.

The author, out a considerable number of instances, recorded twenty-six cases of aural diseases asserted by the patients or their parents to have arisen from cerebro-spinal meningitis. Twelve of these patients were males, fourteen females. Three of them were under three years

[1] New York Medical Record, December 8th, 1883.
[2] Boston Med. and Surgical Journal, September 3d, 1874.

of age, seven between three and five years, eight between five and ten years, five between ten and twenty years, one between twenty and thirty years, and two were over thirty years of age. Among these cases were seventeen deaf-mutes, whilst five were either totally deaf or nearly so. In numerous instances the results of arrested development were apparent and chronic catarrhal changes, etc. Chronic purulent otitis media existed in four cases.

Mumps.—That aural disease may be consequent to parotiditis has been occasionally remarked. Six cases with ear disease, arising, as far as could be ascertained, from an attack of mumps, presented themselves for treatment, though in a large number of other cases this was the alleged cause. Four were females and two males. Acute purulent inflammation of the middle ear was present in one case, the chronic form also in one case. Two patients had chronic catarrh of the middle-ear tract, and two had acute catarrhal inflammation of the middle ear. A few cases have been reported where extreme deafness followed this disease.

Pertussis.—Whooping-cough is sometimes also a causative factor in the production of ear disease. In seven cases notes were taken by the author. Of these four were females, three males. One of these patients had chronic catarrhal and four had chronic purulent inflammation of the middle ear. There was one case also of subacute catarrh and one of acute purulent otitis media.

Typhoid fever is very often alleged to be the cause of aural troubles, by extension of catarrh of the air passages to the middle ear. This is liable to occur during the course of all fevers, the mucous membrane being much more susceptible during the progress of such diseases. Among ten of the cases of typhoid fever of which record was made, otitis media purulenta chronica occurred in five patients, chronic catarrhal inflammation in two, and acute catarrh of the middle ear in one case. In two cases it was doubtful whether the aural trouble resulted from the typhoid fever or from other sources (measles, dental irritation). One case was a deaf-mute.

Typhus, "Roman," "malarial," and other fevers.—As above remarked, catarrhal inflammation of the upper air passages is usually present in all fevers, and aural disease in consequence is liable to occur. The author's records show two cases of typhus fever resulting in deaf-mutism in one patient three years of age, and chronic catarrh of the middle ear in the other. One case of so-called "Roman" fever was followed by otitis media catarrhalis chron., with accompanying annoying tinnitis aurium and autophony. Twenty-six cases of so-called "malarial fever," "chills and fevers," "intermittent fever"

were recorded, fifteen of which were males, eleven females. The aural diseases for which these patients applied for treatment were as follows :

Otitis media purulenta acuta in	2 cases.
Otitis media purulenta chronica in	2 cases.
Otitis media catarrhalis acuta in	1 case.
Otitis media catarrhalis chronica in	14 cases.
Otitis externa diffusa in	1 case.
Otitis externa circumscripta in	1 case.
Otalgia in	2 cases.

In these cases there were symptoms of autophony and general nervous prostration, pruritus auris, etc. Syphilis existed in one case of chronic catarrh of the middle ear.

Opinions differ very much in regard to the influence of a "malarial" poison in the production of aural diseases. Luchhau found otitis media, both the catarrhal and the purulent forms, in fifteen out of one hundred and eight cases of relapsing fever. This author does not think that the aural trouble arose from an extension of the catarrh via the Eustachian tubes. Weber-Liel describes two forms of ear disease dependent on "malarial" poisoning. The one he calls an otitis intermittens, the other an intermittent otalgia, being of a non-inflammatory nature. Similar observations have been reported by Voltolini, Cassels, and others. It seems probable that the presence of catarrhal fever is liable to be regarded by many as "malarial."

CUTANEOUS AFFECTIONS.

Certain cutaneous diseases, such as eczema, erysipelas, herpes, etc., are more or less often causative of ear affections, through extension from the cutaneous surface into the ear.

CHAPTER VI.

CATARRH OF THE UPPER AIR TRACT.

The origin and continuance of aural disease is due to, or associated intimately with, catarrhal inflammation of the upper air-passages in the greater number of instances; but acute and chronic aural catarrh, constituting the principal affections of the ear, may be isolated, or more or less independent of the former.

It has not been long since inflammation of the mucous tract of the head was simply known as a "gathering" in the head. Of late this has given way to a term but little more expressive of the trouble, namely, "a cold in the head." Gradually, however, as catarrhal affections of the ear and nose have received greater attention, their importance is more generally recognized, and it now seems time that the entire pneumatic tract of the head should be considered as a whole, in order that the etiology, pathology, and treatment of this region, or any of its parts, may be intelligently considered. It will be profitable to those who have not already given the subject particular attention, to glance at the pneumatic area of the head, as shown in the accompanying diagrammatic view of this region.

Greater knowledge of the boundaries and extent of the tract may, however, be obtained by studying the prepared bones of the face and head. The osseous fore-front in man will thus be seen to consist of a framework not unlike the bony structure in birds, where extreme lightness is assured without undue loss of strength—a conformation well adapted to the physiological requirements of the special-sense nerve-distribution to the ear and nose. The more important cavities of the head concerned in catarrhal inflammation are: 1, the tympanum, mastoid antrum, and cellules; 2, the turbinated bone interspaces, or nasal passages; 3, the frontal sinuses; 4, the ethmoidal cells; 5, the antrum of the superior maxillary bones; 6, the sphenoidal sinuses. The large sockets for the lodgment of the eyes, the oro-pharynx, and the pharyngeal vault are also a part of this region. The various cavities have connecting sinuses, and the entire system is everywhere lined by mucous membrane.

It is manifest, then, that no one part of the upper air-tract is liable to catarrhal inflammation altogether independently of the others. Before alluding to causation in a broader sense, however, a passing allusion may be made in this connection to several important local anomalies and affections which sometimes stand in a causative relation to catarrh. Thus, deviations of the nasal septum occur often enough to attract attention to their possible influence in causing catarrhal inflammation; where this interferes with free circulation of air and the escape of secretions, it may be not only causative of catarrh, but may also increase its dangers. The relations of deviations of the nasal septum to a high palatal arch are notably frequent, and from a study of a large number of subjects of this defect in catarrhal patients, the author cannot believe that it has any other significance than that it seems to pertain to individuals with marked ovoidal conformation



FIG. 14.—DIAGRAM OF UPPER RESPIRATORY TRACT AND ITS AIR CHAMBERS (OMITTING THE PHARYNGEAL VAULT).

1, 1, Nares; 2, 3, 4, superior, middle, and inferior meatus; S, M, L, superior, middle, and inferior turbinated bones; 5, 5, antrum of Highmore; 6, 6, conjunctiva; 7, 7, posterior ethmoidal sinuses; 8, 8, anterior ethmoidal sinuses; 9, 9, sphenoidal sinuses; 10, 10, frontal sinuses; 11, 11, infundibulum; 12, 12, Eustachian tube; 13, 13, tympanum; 14, 14, mastoid antrum; 15, 15, mastoid sinuses. Drawn by Dr. Robert Barclay at the suggestion of the author.

of the face, who generally have high arched palates along with the lengthened facial measurement.

His own experience in observing catarrhal inflammation of the head and elsewhere, leads the writer to rather regard it as the local manifestation of systemic and climatic influences, than, as some authorities intimate, the result of a purely catarrhal diathesis to the local manifestations of which treatment is mainly to be directed. The writer can but think it a fallacy to consider even a strong predisposition, manifesting itself in the guise of heredity in persons seldom free of catarrh, as demonstrating the purely local nature of the trouble.

In defining catarrhal inflammation, it is well to distinguish between

the deterioration in mucous surfaces which evinces the natural retrogradation consequent on gradual but sure decay, and the conditions that hasten the process, and, therefore, call for medical treatment. But while the natural retrogression is in a measure irremedial, yet it is much less active in the strong and healthy. Catarrhal inflammation manifests itself very differently in different cases; thus the healthy and strong withstand its influences, while the weak and susceptible yield readily. The predisponents and excitants of catarrh give coloring to its manifestations; thus, urban and rural environments, respectively, with the diversity in the habits or occupations of individuals, together with climatic differences, produce very different effects, and it will be well to review their peculiarities separately.

Urban peculiarities.—In cities mental strain from overwork, worry, and dissipations of every kind—in a word, civic wear and tear—gives rise to nervous exhaustion, and consequently to physical disability.

To the above should be added the ceaseless noise and the exceedingly deleterious dust and offensive and noxious odors with which metropolitan air is generally laden.

Persons reared in cities are, moreover, deprived of the tone and vigor imparted by country life. The mucous membrane of the air-passages in all persons is thus exposed to a variety of local excitants, but among clerks and operatives it is especially liable to become inflamed. Perhaps worse than all else is the pernicious system of overheating dwellings, hotels, school-houses, public resorts, factories, railway carriages, and sea-going vessels. Provision is thus made for the comfort of the ailing or indolent on the one hand, and the economical distribution of heat on the other, without due regard for the consequences on health. These unwholesome conditions are the outgrowth of luxurious civic life, the concentration of mercantile and manufacturing interests, the criminal neglect to keep streets and houses clean, and defective drainage. Thus, while out-door air has its impurities at all seasons, it is scarcely possible during the winter to live in-doors without experiencing the ill effects of overheated and impure air, the tendency of which is to deprive persons of the hardihood necessary to resist the unavoidable and natural vicissitudes of out-door life.

The liability to contract catarrhal affections from exposure of the feet, trunk, and head, in street cars, to draughts of cold air in all seasons is very great.

Rural peculiarities.—Very different from the foregoing are the usual conditions of country life; here physical overwork is more likely to be met with as compared with mental, although worry and

grief in various forms are not unknown. Among pioneers in new settlements homesickness often exists, the food supply frequently is inadequate, and habitations damp, cold, and dark. The statement applies to laborers in public works, and often to men in the frontier military service. In older and improved country places, where extreme exposure is exceptional, catarrhal inflammation is not so severe, yet the causal influences and symptoms differ from those of the city. It may be said that the rural subject presents the sthenic type, with greater temperature disturbance, while in the city patient, if a subject of nervous exhaustion, it is more likely to assume an asthenic form.

The difference in the phenomena observed in what may, for comparison, be designated as two classes of catarrhal disease serves, perhaps, to explain some apparent discrepancies in the conclusions arrived at by medical men, who have looked on the same disease from a different point of view, some regarding it as catarrhal inflammation, others as malarial fever.

But this is not so surprising, since catarrhal inflammation often exhibits symptoms commonly, though wrongly, ascribed to malaria; thus fever is often present, being ushered in with chills; there is a tendency to recurrence, malaise, depression of spirits, vertiginous symptoms, and the like. The subsequent debility and typhoidal symptoms, when present, are therefore liable to mislead the observer, especially if he be a believer in the production of typhoid fever from "malarial" influences. One should reflect here on the possibility of these symptoms being due to disturbance of the nervous system wholly.

Malaria has long been a convenient cloak for our ignorance in respect to the origin of disease. The writer recollects how the "bilious remittent" fever of the Southwest was attributed to this cause in his early experience; and an outbreak of so-called "typho-malarial" fever among the soldiers of his regiment while stationed in the Alleghanies, in 1861, occurring after some weeks' exposure in camp, especially to night air, was alleged to be due to this agency. The popular mind to-day gives credence to this mysterious influence, as it always has done for hundreds of years.

Says Cooke, in a recent work on Virginia, speaking of the early settlers on the James River in 1607: "With July came the sultry dog-days of a southern summer, and the marshy banks of the river, sweltering in the sun, sweated a poisonous malaria which entered into the blood of the English. The whole colony was prostrated by a virulent epidemic." Thus, as at tide-water two hundred and fifty-

four years before, was the origin of a disease assigned to the same causation in the mountains in 1861. In both of the instances named, men were suddenly transferred from civil life to an out-door existence, in which little care was taken to properly habituate themselves; sometimes they were idle and inactive for weeks and months, until some emergency called forth their utmost exertions, leaving many greatly exhausted. As a class they were without self-restraint, and neglectful in respect to both food and hygiene. Were not physical influences manifestly the cause of whatever affection these people had, rather than mythical ones? A gentleman, competent to give an intelligent opinion, and who has long practised medicine in tropical South America, once said to the writer, in discussing this subject, that it was his belief that the severe fevers of that country might justly be regarded as an aggravated form of catarrhal inflammation.

The confounding of symptoms alleged to arise from so-called malarial poisoning with catarrhal inflammation (inclusive of nervous phenomena so often present) seems to have for its origin the belief that a malignant miasm exists in the emanations arising from decaying animal or vegetable matter, sewer-gas, stagnant water, etc., or is disseminated by the pollen or effluvium of plants. It is to be regretted that the accumulated literature of this subject, embracing the labors of writers for many centuries, cannot by incontestable evidence establish these tenets; proof of the existence of malarial poison, according to a contemporary authority, lies mainly in the alleged fact that the sickness it causes yields to the administration of quinine.

In accepting the miasmatic origin of disease, it has been found convenient to explain its morbific influence through zymotic action, and more recently the microbic theory has been advanced; but whether the "fermentation" of zymosis and the presence of bacteria in the blood are not a product rather than a cause of disease, may well be believed.

The neglect of cleanliness, or, more broadly, of sanitation, is fraught with much evil; but while fully recognizing the danger to health from decomposition of animal and vegetable matter, would not a healthier sanitation prevail were the popular "fetich of the sewer," to which such quantities of quinine are sacrificed, put aside? How often has house-drainage been laid under unjust suspicion in pursuit of this imaginary evil; the wall-paper of the sick-room even torn down in the search after the sewer-pipe has been overhauled, or the house abandoned entirely? How often have worry, dissipation, and exposure, lowering the tone of the nervous system, overtaxing

the stomach with alcoholic drinks and indigestible food taken at all hours, breathing the poisonous air of the ball-room, theatre, and the like—probably continued for a "season"—been the cause of sickness unjustly attributed to defective drainage?

It may be well to consider the causes of catarrh of the head somewhat broadly, since the belief has taken deep hold on the minds of many that the malady is purely local; when the influences lying behind local manifestations are thus recognized, it is believed a more rational treatment will prevail. Among the causes are:

Meteorological influences.—Lightning stroke, sunstroke, and congelation are not, of course, in the ordinary sense, to be considered as causal; it is the less or entirely inappreciable, and hence unexpected, variations in meteorological conditions that interest us, more especially because they are liable to be underestimated or overlooked entirely. These changes consist in variations in thermal, electrical, and aqueous vapor tension, inclusive, consequently, of the relative amount of sunlight, oxygen, ozone, etc. The most important of these, and doubtless influencing them all in greater or less degree, is the heat radiated from the sun. Animal and vegetable life upon the earth's crust derive their vitality from this source. It is the struggle against the undue loss of this heat through radiation from the earth's surface on the one hand, and the avoidance of an excessive supply on the other hand, in order that a healthful equilibrium may be maintained, that concerns the sanitarian. Circumstances have placed man alike in warm and cold climates, as well as in the more favored temperate latitudes; the latter is most favorable, since out-door life may be enjoyed to a greater extent than elsewhere. It behooves one, therefore, in considering the causes of catarrhal inflammation, to take into count weather vicissitudes, including a study of meteorological physics, the laws regulating heat, electrical and aqueous vapor tension, the movements of wind and water (trade and anti-trade winds and ocean currents); the proportion of oxygen, ozone, etc., under varying conditions.

The functions of life for the most part must be carried on in an environment of ever-changing physical forces. We may be said to live amidst ceaseless aerial cyclonic movements of greater or less energy, since the air is ever in motion; these storms—sometimes one following the other, sometimes moving along in an irregular manner together—traverse to a greater or less extent the entire continent, disturbing a varying area of territory. As the cyclone constituting the ordinary thunder-storm advances, there is always a higher temperature in front than in the rear—"the warm air in front," accord-

ing to Mr. Abercromby,[1] "having a peculiar, close, muggy character. The cold air in the rear, on the contrary, has a peculiarly exhilarating feeling." These conditions are quite independent of the thermometrical condition.

The following puzzling experience is illustrative of the effect of these influences; it occurred in the writer's early experience in practice. The patient was a man, aged forty-five, whose general health was fair; on entering the sick-room the writer found him gasping for breath. The heart was beating tumultuously, and his nervousness was painful to witness. He had been attacked with these symptoms on the approach of a thunder-storm which was then prevailing. His wife, who showed no alarm, informed the author that he always suffered in this manner during storms, and that recovery was always speedy and complete as soon as the weather cleared.

Sudden and extreme changes in altitude also give rise to peculiar disturbances; persons on arriving, by rail, at an elevation of some sixteen thousand feet in the Andes, are liable to experience very disagreeable sensations, due to the sudden withdrawal of atmospheric tension. Besides the cardiac failure and pulmonary derangement produced by the transition, congestion and anæsthesia of the skin, cramps, and other nervous disturbances are experienced, known in South America as "aire."[2] Similar to phenomena occurring in very much *rarefied* air are those witnessed in persons exposed to the highly *condensed* air of submarine caissons; in either the sudden disturbance of equilibrium of density causes undue nervous strain.

It is, however, the much more slight variations associated with storm movements that probably give rise to the nervousness experienced by certain individuals. The writer has been informed by a number of his patients that they cannot long endure a sea-side residence in summer, even in so agreeable a place as Newport, R. I., on account of the extreme nervousness apparently produced by an environment affected by wind that has swept rapidly over the ocean for a long distance. Besides the general nervousness experienced, there was irresistible somnolency at one time, and at another a total inability to obtain sleep.

The writer believes that natural electrical disturbances exert an important influence on the health of persons whose nervous systems have been impaired by exhaustion, causing undue excitation or de-

[1] Nature, 1885.

[2] Report of Medical Inspector Benjamin F. Gibbs, U. S. Flag-ship Richmond, South Pacific Station, 1876.—Hygienic and Medical Reports by Medical Officers of the U. S. Navy. Washington, 1879. Page 270.

pression according to the positive or negative state affecting them. Indeed, it is probable that very slight disturbances of electrical tension often produce decided nervous phenomena. These electrical variations have not, as yet, been fully studied, but many observations have been made going to prove their existence. Thus, the author has been informed by Dr. James P. Kimball, now Director of the Mint, that, what he has long suspected as causing this, namely, disturbance of electrical equilibrium by the wind in motion, is true; that during certain high winds the electrometer showed a decided variation. Observations in respect to the electrification of the air have also been made elsewhere; in referring to the "normal positive difference of potential between a point some few feet above the earth and the ground itself," C. Michie Smith,[1] of the Madras Christian College, points out "that, in Madras, at least, a negative electrification of the air was a normal, and not an abnormal condition for many hours of the day at certain seasons of the year. Observations since taken have entirely confirmed the opinion that with a hot, dry, west wind the air in Madras is usually negatively electrified, and often to a very high potential." . . . "During periods of incessant discharges of sheet lightning which we often experience here, the electrification of the air is sometimes positive and at other times negative, but generally positive."

Thermal changes are yet more important than either electrical or barometrical. The rapid liberation of heat from the body of the strong generally arouses healthful activity, but it depresses the weak; on the other hand, the acquisition of a relatively great amount of heat is well borne by the former, while prostrating the latter.

Prolonged exertion in extreme summer heat gives rise to nervous prostration or irritability; this is especially liable to occur during the "dog-days" of summer, the mean daily temperature continuing high, when even slight exercise is fatiguing and attended with perspiration. A draught of air is then, according to the Spaniards, *una facada*, a knife-stab, so dangerous is it regarded. But, as would be expected, exposure to night air when the sun's heat is withdrawn, is particularly dangerous to the susceptible.

(As we approach tropical climates, the transition from night to day and from day to night is sudden, and without the twilight of more northern latitudes.)

It is then that *sudden* cooling off, especially in damp clothing,

[1] Nature, January 29th, 1888.

and while the body is overheated, that catarrhal inflammation may occur.

It was long ago shown by Dr. Wells that when the sun has set the earth's surface becomes quickly cooled by radiation, and the air immediately above becoming too cold to retain its aqueous vapor in a state of suspension, the moisture is therefore rapidly deposited upon the earth in the form of dew or frost, according to the lowness of temperature. It will be observed that dampness often shows itself upon the turf sometimes before the sun has sunk, and from this on the dampness and chilliness of the under stratum of air increases more and more up to a certain point. The intelligent class of natives of the tropics practise much caution to avoid the deleterious effects of this exposure, but notwithstanding their prudence, catarrhal affections of a severe character prevail. This result is less surprising, however, when the effect of prolonged summer heat in producing apathy and inertia—totally preventing exercise, and thus increasing susceptibility—is considered.

Night air at sea is likewise to be avoided, since even the general bracing effect of ocean air by no means insures immunity from catarrhal trouble.

Usually, however, we have to consider the influence of slight impressions only on the nervous system ; these have been distinguished as a "shock" or a "stab," although but a slight immediate effect is experienced. In the end, however, very decided phenomena are produced through the vaso-motor system of nerves. A susceptible person may not remain with uncovered head for many minutes in the dew-laden tropical night air without sneezing or even contracting rhinitis. Greater or long-continued exposure, especially in run-down persons, may be followed by ague, dengue, neuralgia, or rheumatism, according to the patient's idiosyncrasy or susceptibility. Of course, the hardy native "of the soil," so to speak, becomes acclimated to vicissitudes by long residence, and even the languid and more unstrung resident acquires immunity not to be enjoyed by strangers.

Thermal variations, otherwise inappreciable, visibly affect the system when run down ; thus, in a six-days' summer voyage from Suez to Aden, says Medical Director Delavan Bloodgood, U. S. N., in a letter to the writer, the temperature was seldom lower than 100° Fahrenheit, day or night ; on entering the Gulf of Aden, however, a breeze encountered, only a few degrees lower, produced such a chilling sensation that the passengers found an increase of clothing absolutely necessary. This gentleman recalls now, after many years, the chattering of his teeth on that occasion, and the discomfort lasted for

several hours. It is not unusual under these circumstances to experience an immense increase in urinary secretion, and the ship's surgeon in consequence always receives the visits of a large number of surprised, if not alarmed, passengers. Experiences of practical interest bearing on this point are common enough to travellers. Thus Stanley found, after travelling for some considerable time in the relaxing climate of equatorial Africa, that warm clothing, including an ulster, was comfortable in July, when the minimum temperature was 63° F.; and the draughts of wind sweeping down the gorges, though not decreasing temperature thermometrically, added greatly to the feeling of "miserable chilliness." The catarrhal manifestations which seemed to prevail on the Congo under those circumstances were of the gastric variety. Mr. Crawford, a gentleman engaged in selecting a railway route across the Pampas during the hot months, notes the rapid changes in temperature on La Plata; a sudden fall from great heat to 26° F., water freezing in the tents on one occasion, and at Mercedes on another, after an intensely cold night, the thermometer registering 34° F., the temperature rose to 107° F. in the shade at 4.30 P.M.

Forbes, while travelling in the Eastern Archipelago, found the natives in Sumatra going about, and even sleeping, in all weathers, nearly naked, and enjoying good health; but almost at once succumbing to the low temperature of mountain heights, often actually dying before they could descend. Mr. Forbes, in his admirable work "The Wanderings of a Naturalist in the Eastern Archipelago," states that, at an elevation of 10,562 feet up the Dempo, the midday sun was almost unendurably hot, the hands, face, and neck being scorched the moment they came into the sunshine, though a cold wind was blowing and the thermometer registered only 63° F. When the sun began to deline, however, the temperature fell rapidly; at sunset it was 47.2° F., and for comfort he was obliged to put on three suits of clothes.

"When at four o'clock next morning," says Mr. Forbes, "I went out into the Sawah, though the thermometer registered 47° F. (the lowest reading of the night was 42° F.), the air, which was perfectly still—its silence, indeed, almost overwhelming—felt absolutely free from rawness, in marked contrast to what I had experienced at sunset under almost the same reading of the thermometer."

Mental exhaustion alone, without open-air exposure, is very often a cause of head catarrh; yet may one sleep in a cold, airy apartment, when not overheated, without risk, and patients with high temperature, unless sweating excessively, get on best with such surroundings.

Causative influences like the foregoing finally prevent healthful equipose between the different organs, and, in consequence of this, elimination is defective. Along with defective nutrition a perverted state of the nervous system obtains; its tension, on the one hand, is depressed, or, on the other hand, increased. At either extreme, or in vibrating between them, peculiar phenomena present themselves; thus periodical disturbances influencing temperature may characterize catarrhal fever, or they may manifest themselves as "nervous explosions" at irregular intervals. Certain subjects become known as "nervous," and are liable to uncontrollable sighing, weeping, outbursts of ill-temper, and other emotional manifestations. Others thus illy-balanced indulge inordinately in stimulants, or food, or sexual excess. It is a notable fact that such nervous persons are extremely subject to catarrhal inflammation, which is liable to take on nervous characteristics. Thus, with bronchitis appears the suffocating spasm of asthma, and with rhinitis the violent irritation and sneezing of hay-fever. Catarrhal neuroses, once acquired by the more susceptible, increase by long continuance to a degree never experienced by less sensitive persons. These local disturbances of the mucous surface are comparable to neuroses of the skin, as zoster and pruritus, where cutaneous burning and itching are caused by reflex action.

Where the asthmatic habit exists, meteorological disturbances, excessive physical exertion, undue mental excitement or depression, cold winds and dust, excite spasm and cough. The sight of dust, even without inhaling it, will excite spasmodic cough; indeed, almost every asthmatic has his *bête noire*, which may explain the whimsical origin of asthmatic spasm in some cases.

In the disordered olfaction of hay or rose fever, the odor of the rose and other objects is compared to the irritation of pepper applied to the Schneiderian membrane, and, as in asthma, various dusts and odors cause distress.

The rhinitis of hay and rose fever is often found to stand in a causal relation to otitis, affecting the ears either by extension of the inflammatory process from the naso-pharynx up along the Eustachian tube to the tympanum, or through reflex sympathy of the nerves.

The more decided catarrhal attacks are, of course, well known to be ushered in by a chill, with more or less nervous disturbance; sometimes a local manifestation also occurs, as torticollis, or a "crick" in some other region. In the greater number of cases, however, intense congestion of the Schneiderian membrane occurs, producing

sensations of dryness and heat, violent and persistent sneezing, and often a tickling feeling.

Secretion in catarrhal inflammation is generally characteristic; thus the outpour of fluid from the inflamed mucous membrane of the nose in children, after the feverish stage at the onset, is profuse, as it also is in recurrent rhinitis in adults, notably in hay-fever. Incrustations of inspissated muco-pus in the caverns of the nose, especially where a deviation of the septum exists, are seldom seen before puberty; but in chronic catarrh in cachectic persons, or in advanced life, where the mucous membrane enveloping the erectile tissue of the nose has become atrophied, evaporation of the scanty secretion leaves inspissated crusts, which often soon become fetid.

Bleeding abrasions, due to congestion of the nasal mucous membrane, especially in persons living under mental strain and worry, are common and liable to become the seat of these crusts. The latter cause much discomfort, their removal being often followed by more or less bleeding. In some cases the perichondrium is exposed and the septum may even finally become perforated. There is an intermediate stage when mucous secretions become very tough on drying and are worked out with difficulty. Secretion may consist of mucus principally, or it may become sero-mucous, sero-sanguinolent, muco-purulent, purulent, or otherwise combined, according to circumstances. During the further progress of the trouble the lower air-tract is often invaded, accompanied by cough and other symptoms of bronchial catarrh.

Head catarrh often begins very early in life, and continues a long time before the subject is brought to the physician's notice. In fact, it is usually neglected until marked deafness has occurred. The neglect of nasal catarrh is often due to the indifference to the slight discomfort attending impairment of smell, since at best this function is less perfect from disuse or want of cultivation than that of the other special senses. In a few instances the author found the sense of smell most acute, resembling that of many of the lower animals, where its importance in the economy is scarcely second to hearing and seeing.

Sympathy of the Nerves.—In certain conditions of the system the nerves become exceedingly impressible to excitation; thus the irritation produced by the introduction of a speculum or a probe into the external auditory canal will excite coughing, or a desire to swallow, and various other sensations in the nose, pharynx, or larynx. Many persons can locate the seat of local irritation thus propagated in the ear in some particular spot in these parts, the sensation being de-

scribed as "burning," "tickling," and the like. *There is very often an increase in the secretion of mucus in the spot thus irritated.* When the throat is in a diseased condition, the reverse of the above often takes place, and the ear may then become affected. When nerve-tension has been long disturbed in this way, reflex phenomena are easily excited; continuous aural, nasal, or dental irritation, even if imperceptible, may affect one part or another, until nutritive (trophic) changes are brought about; slowly progressive aural catarrh finally producing deafness before the patient himself is aware of any morbid action going on. The tissues involved in catarrhal inflammation of the middle ear consist of a membrane which performs the double duty of mucous membrane and periosteum. The sensitive-



FIG. 15.—DIAGRAM OF THE TYMPANIC PLEXUS (RÜDINGER).

1, Oculo-motor nerve; 2, trigeminus nerve, with the Gasserian ganglion; 3, first branch of the trigeminus nerve; 4, second branch; 5, entrance of the same into the spheno-palatine fossa; 6 and 7, superior maxillary nerve; 8, spheno-ethmoidal nerve; 9, descending palatine nerve; 10, Vidian nerve; 11, large superior petrosal nerve; 12, buccinator nerve; 13 and 14, pterygoid nerve; 15, chorda tympani nerve; 16, carotid plexus of the sympathetic; 17, petrosal ganglion of the glosso-pharyngeal nerve; 18, 19, and 21, vagus, accessory nerve of Willis, and hypoglossus; 20, facial nerve; 22, nervali carotico-tympanici; 23, tympanic, or Jacobson's nerve; 24, small superficial petrosal nerve; 25, nerve of the tensor tympani; 26, tympanic plexus; 27, branch for the oval window; 28, branch for the round window; 29, large, deep-seated petrosal nerve; 30, branch for the Eustachian tube; 31, division of the Vidian nerve into its two branches; 32, anastomosis of fasciculus of the Vidian nerve.

ness of this structure is extremely great, for it is not only richly supplied with blood-vessels, but also wonderfully well provided with sensory nerves. These latter compose the tympanic plexus, a diagram of which is here shown. This anastomosis derives supplies from sources most extensive; thus by means of branches from the otic ganglion the inferior maxillary nerve is brought into intimate relations with it, and the petrosal ganglion of the glosso-pharyngeal

nerve supplies the tympanic branch, or Jacobson's nerve, which constitutes a large portion of this anastomosis. The carotid plexus of the sympathetic sends a branch to the glosso-pharyngeal, and thus establishes a communication between the ear and the superior cervical ganglion of the sympathetic nerve. Through Meckel's ganglion, by means of the Vidian nerve, the superior maxillary of the fifth pair of nerves also is connected with the tympanic system. Besides these, there are other connections which may be seen by consulting the diagram.

This extensive nervous connection brings the ear into sympathetic relationship with disturbances in various parts, as the brain, stomach, heart, genito-urinary organs, and cutaneous surface, as well as with other parts already mentioned.

From an etiological point of view, catarrhal affections of the upper air-tract should be considered as a whole, although the ear, as before stated, as well as the olfactory region, or in fact any of the other cavities and sinuses of the head may become independently affected. The special catarrhal affections of the ear will be considered in another part of this work. Of great importance, and one too often overlooked entirely, is the influence of dentition, together with the retention of dead teeth, etc., in the jaws, as active causative agents of catarrh.

Invasion of the upper air-tract by catarrhal inflammation is, as already stated, common in a large majority of aural diseases. Among the recorded cases of the author's, catarrh of these parts has been noted down as being very marked in 1,772 cases of aural trouble. An analytical tabulation of these shows the relative age, sex, and other conditions with which aural disease is generally found to exist.

FEMALES.		MALES.	
Age.	No. of cases.	Age.	No. of cases.
Under 3 years,	25	Under 3 years,	37
3 to 6 years,	69	3 to 6 years,	52
6 to 15 years,	173	6 to 15 years,	163
15 to 20 years,	68	15 to 20 years,	105
20 to 30 years,	156	20 to 30 years,	244
30 to 40 years,	98	30 to 50 years,	350
40 to 50 years,	75		
Over 50 years,	49	Over 50 years,	108
	713		1,059

Total Males,	1,059
Total Females,	713
Grand Total	1,772

ith which these patients were affected were as

Chronica,	863
Acuta,	138
Subacuta,	85
Chronica,	398
Acuta,	280
Subacuta,	8
	1,772

se cases shows that in 393 of them the tonsils ; in 6 there was acute tonsillitis, in 5 quinsy, 85 chronic suppurative rhinitis (ozæna), 401 were ecurrent head catarrh (cold in the head), an evi- l susceptibility to the usual exposure and vicis- s already been mentioned that oral or dental egarded as occupying a causal relation to catarrh ges. Among these 1,772 cases, there were 1,109 irritation was found to exist. These disturbances were ition, caries of the teeth, and consequent alveolar abscess, ons of tartar, gingivitis, glossitis, aphthæ, and (in 79 cases) ation from the wearing of vulcanite and ill-fitting dental

he more rare occurrences was one case of congenital fistula nx, four cases of abscess of Highmore's antrum, four cases atarrhal inflammation of the frontal sinuses, one case of the hard palate, nine cases of gumma of the soft palate sion to the posterior wall of the pharynx, two cases of the pharynx, six cases of cleft palate, and four cases of al anomalies, with one case of perforation of the anterior lcer of the pharynx was found in one case, and adenoid twenty cases.

la was notably elongated in six cases (the moderate elonga- not recorded). Eleven cases of double uvula were seen, anomalies of this organ existed in two cases. The uvula to one side in ten cases (marked instances only of this not unusual symptom were recorded); it was absent in one case. Very marked deviation of the nasal septum was noted as causing obstruction in twenty-five cases and the very general existence of slight deformity was noticeable. The septum was perforated in two cases and absent in one. Excoriation of the nares was found in two cases, caries of the bones in two cases, and nasal polypus in five. There

was deformity of the nasal organ in two cases and arrest of development in one case.

Standing directly or indirectly in a causal relation to the catarrh were 85 cases of syphilis, 66 of scarlet fever, 30 of measles, 13 of diphtheria (probably in some instances the angina of scarlatina), 9 of bronchitis, 8 of pulmonary phthisis, 9 cases of laryngitis, 2 of whooping cough, 8 cases of "malaria," 2 of typhoid-fever, and 1 each of mumps variola, and epilepsy. In 93 cases there was marked disturbance due to the menopause, pregnancy, or some uterine disease. In 20 cases, the occurrence of conjunctivitis (mostly in children) was observed to occur along with acute catarrh of the upper tract. In 262 cases, the external auditory canals were the seat of ceruminal collections, and in 70 cases there was either circumscribed or diffuse inflammation of the canals.

In one case, a female aged 64 years, in whom some deafness had existed for twenty years, there had been, during the past twelve years, an increase of the head catarrh in connection with suppurative inflammation of the left superior maxillary antrum. The carious tooth giving rise to this complication was also attended with alveolar abscesses, which continued to form after the pulp had been destroyed by a dentist, who, notwithstanding its painfulness, advised its retention in the jaws. Deafness was observed to have advanced much more rapidly on the affected side (left).

In the case of a male patient, 28 years of age, deglutition had been difficult and painful for five months previously, and for the past month deafness had been developing. An unsuspected gumma of the soft palate was found. The palate and uvula were œdematous and there was a thick viscid discharge from the nose and pharynx affecting the voice. The skin over the bridge of the nose was much flushed, and it was found that the natural contour of the organ was lost.

In the case of a male patient, aged 38 years, intensely severe recurrent attacks of head catarrh were attended with increased ceruminal secretion. In the following cases more or less deafness existed.

CASE 1.—Army officer, age 39 years, neuropathic temperament, intemperate and having long suffered from a severe gun-shot wound, began suddenly to suffer from very severe recurrent rhinitis. The right naris during an attack becomes closed by the swelling, and he experiences a sensation as though a worm were "wriggling about in efforts to get out." The distress and nervous irritability are almost unendurable. The disease first showed itself sixteen years before and at the onset there was painfully persistent sneezing which lasted for eighteen hours.

CASE 2.—A female, aged 28 years, subject to head catarrh for the

past four years, cannot breathe through the nose at night, owing to the accumulation of inspissated muco-purulent crusts.

CASE 3.—A male, aged 17 years, the subject of head catarrh, has not been able for two years to breathe through the nose, either while waking or sleeping. The nasal passages are abraded from irritation with the finger nails and painful to the touch. Crusts often accumulate, and the voice is nasal.

CASE 4.—A female, aged 44 years, states that seven years ago she contracted the then prevalent epidemic nasal catarrh (epizootic), succeeded by rhinitis sicca, which has since continued with loss of taste and smell.

CASE 5.—A female, 3½ years of age, has very large tonsils, which are so completely enveloped in the lateral half arches as to be almost invisible. There is chronic rhinitis, constant snuffling, and great susceptibility to head catarrh. (Many cases of this kind are seen, and here the foundation of great deafness is often laid.)

CASE 6.—A female, aged 35 years, subject to quinsy sore throat until her fifteenth year, has now purulent rhinitis consequent to syphilitic taint. Aural catarrh and deafness has developed within the past few years.

CASE 7.—Female, æt. 43 years (married). For past four years rhinitis with much secretion, giving rise to constant hawking. The ears finally became affected. Subject to recurrent exacerbations which cause increase of her deafness.

CASE 8.—Male, 5½ years old, with congenital cleft palate, as has his father also. The tonsils have become greatly enlarged since an attack of diphtheria (?) when the patient was eighteen months of age, and since having whooping-cough, eight months ago, the difficulty has increased. The tonsils, which are of enormous size, meet, and breathing is difficult, especially at night. Removal of the tonsils was followed by relief.

CASE 9.—Male, aged 38 years, contracted syphilis sixteen years ago. Secondary symptoms followed, and finally the nasal bones became affected. Two months ago subacute catarrhal inflammation began in the right ear.

CASE 10.—Male, aged 29 years, says general health and habits are good (?), but has had purulent rhinitis sicca for most of his life. The pharynx is large, vascular, and thickly studded with adenoid developments. For past five years has been subject to acute catarrhal inflammation of both ears.

CASE 11.—Male, 46 years of age, served in Mississippi Valley during the War of the Rebellion as assistant paymaster, since which time he has been very susceptible to head catarrhs. The back, between the shoulders, is the region of greatest sensitiveness, and attacks of catarrhal inflammation are usually ushered in or accompanied by such disturbances of sensation. The mucous membrane of the pharynx is much thickened and covered by a dirty looking secretion. Patient hawks a great deal.

CASE 12.—Female, aged 24 years. From draughts and other vicissitudes has severe head catarrh several times each winter. The invasions are marked by well-defined periods; they come on suddenly with a down-pour of aqueous fluid from the nose, lasting about three days, irritating the outlets and excoriating the prominent upper lip. This is followed for a period of the same duration by a feeling of increasing tightness of the frontal sinus region, causing great distress. Then the "head breaks," and relief comes with muco-purulent discharge of some three days' duration. Altogether a week of severe symptoms is experienced.

CASE 13.—Male, aged 32. Neuropathic temperament; had severe nasal catarrh when fourteen years of age, and since his twentieth year recurrences have been frequent. The sense of smell is perverted, "dried cod-fish odor" being usually present. The mucous membrane of the naso-pharynx is a good deal congested, and he has much hawking. Patient is very susceptible, taking "head-cold" even when his hair is cut. The aural catarrh gives rise to much deafness.

CASE 14.—Male, aged 29 years. Neurasthenic temperament; has long had nasal catarrh, but has given no attention to its treatment. Marked follicular tonsillitis; the distended crypts are filled with cheesy exudation. Patient is a civil engineer, and has spent much time in Colorado, where the alkaline dust inhaled is very irritating to the air passages. For the past three months the catarrh of the upper air-tract has been especially severe, involving the frontal sinuses. There are numerous very carious teeth. It is noteworthy that this patient was not in any way concerned about his condition until the hearing became affected.

CASE 15.—Male, aged 51 years, with an exceedingly neuropathic temperament, served throughout the War of the Rebellion. In addition to being very nervous, he is subject to rheumatism. Has been anxious about his condition for three years past, during which time treatment was directed to the stomach. Rhinitis sicca is pronounced, and the aural catarrh is of the same atrophic nature, giving rise to distressing deafness.

The records show that catarrh is found equally as often in the blonde as in the brunette. In young females with difficult or imperfect menstruation, the tendency to swelling of the erectile tissue of the nose with perversion of the sense of smell, and engorgements of the tonsils and consequent difficulty in swallowing, or neurotic sensations in the throat giving rise to choking sensations, were so often met with as to be regarded as of the greatest significance. Such persons were exceedingly liable to acute purulent inflammation of the ears. Among the intemperate syphilitic subjects, rhinitis sicca and purulent otitis media with tendency to collections of desiccated muco-pus in the middle ear-tract, were notably associated together.

CHAPTER VII.

ORAL IRRITATION.

Dentition, Caries of the Teeth, etc.—The sympathetic nervous connection between the ears and other organs has long been known; thus Hieron. Mercurialis states in one of the earliest monographs on the eye and ear, in speaking of the latter, that scratching the ears excites coughing (*"primo quia si aures scalpantur, protinus excitatur tussis"*).[1] The celebrated anatomist, Du Verney, however, whose well-known treatise on the ear was published in 1683, makes no allusion to the nervous relationship between the teeth and ears. Our attention was specially drawn to the subject by the writings of Dr. Cooper,[2] whose article on the difficult eruption of the wisdom teeth is very instructive.

Both the eruption and decay of the teeth give rise to greater or less local irritation in the gums, a region richly supplied with blood-vessels and nerves, and, as before stated, there is reason to believe that even in the embryonic state premature activity in the *deciduous teeth*, causing reflex disturbance, may give rise to irritation in the gums. We find the ear very often affected by sympathetic dental irritation in infancy from the time of the appearance of the two central incisors of the lower jaw, which are cut at about the seventh month, until the completion of the first dentition at about the end of the second year. The local disturbance during the eruption of these teeth is sometimes truly alarming, even periostitis of the jaw occurring in the more severe cases.

The deciduous teeth are extremely fragile in children of low vitality, and decay very rapidly; they frequently give rise to toothache and earache at the same time. The shells of temporary teeth found imbedded in the gums long after absorption of their roots are liable

[1] Tractatus, etc. (De Aurium Affectibus prælectiones), Venice, 1590, pp. 51–52.

[2] Clinical Lectures upon Inflammation and Other Diseases of the Ear, London, 1878, pp. 99–104.

to cause irritation, and should, therefore, be removed. Such is the nervousness of teething children that they are seldom free from head colds in consequence of their great susceptibility. The irritation created in the gums of infants during dentition will often, on examination, be found to have caused more or less hyperæmia in the ears where attention has not been directed to the aural region by earache. Even purulent otitis is often well established before the physician is

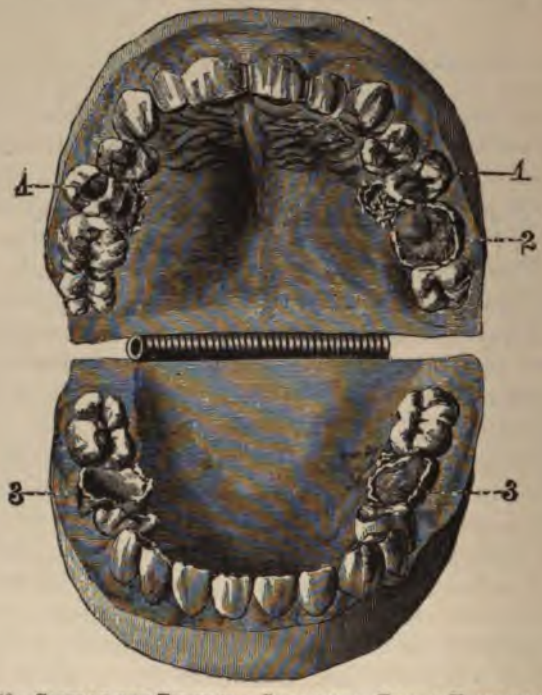


FIG. 16.—CASTS OF THE TEETH OF A SCHOOL-GIRL, TWELVE YEARS OF AGE.[1]

The casts are represented as being held together by a hinge. 1, 1, The second bicuspid teeth of the upper jaw, both of which have been crowded out of place as they erupted by the remains of the fangs of the temporary second molar teeth; these fangs, which have been too long retained in the gums, are seen in the cut just inside the second bicuspids. The retention of the fangs, together with the crowded and irregular condition of the permanent teeth which have just been cut, gave rise to much irritation. This anomalous condition of the teeth is by no means an unusual occurrence where the teeth are neglected. 2, The left upper six-year molar tooth, which is very carious. 3, 3, The two lower six-year molars, both of which have been destroyed by caries. The little girl from whose teeth these casts were taken suffered from deafness and frequent attacks of pain in both ears, and, as she herself expressed it, "the decayed teeth had ached very much all around."

[1] The author's collection of 170 plaster casts of the teeth from which the accompanying three cuts were selected, is now in the Army Medical Museum, in Washington; a descriptive catalogue of them has been prepared by the Surgeon-General's Office for publication.

consulted; and deafness being difficult of detection at an early age, some cases become deaf and dumb before any symptom has specially directed attention to the ear. The physiological progress of dentition may take place without any severe reflex disturbances, but the evolution of the dental germs often assume a pathological interest,



FIG. 17.—VIEW OF PLASTER CASTS OF THE UPPER AND LOWER TEETH OF A YOUTH AGED TWENTY-TWO YEARS.

and grave cerebral irritation may ensue, complicating very much the diagnosis of acute aural disease so common in infancy.

Second Dentition.—This commences between the end of the fifth or the beginning of the seventh year. As the first molars of the per-

manent teeth come through the gums at about the sixth year, the milk teeth, together with their alveoli, suffer re-absorption. Second dentition is concluded (with the exception of the wisdom teeth) by the cutting of the second permanent molars at the twelfth or thirteenth year, the rest of the permanent teeth coming gradually in as the temporary set falls out. The permanent teeth are, like their predecessors, liable to be attacked by caries as soon as they are cut. The first of this series, called the first or "six-year" molar, is specially disposed to decay as soon as it comes, since during its eruption there is generally much irritation in the jaws from the other teeth, besides the occurrence of systemic malnutrition during the exanthemata of childhood, etc. Under these unfavorable influences, it is imperfectly developed, and hence very susceptible to the usual causes of decay. It is, furthermore, generally thought that this tooth belongs to the temporary set, and no notice is taken of it until pain results from exposure of the pulp cavity, caused by excessive decay.

During the first and second dentitions the mouth has but little rest. The whole period of the first is frequently an uninterrupted painful process, which is rapidly followed by the steady advance of the second teeth, whose early decay is imminent. To this must be added the irritation of adherent fragments of the milk teeth, and the not infrequent anomalies of development, neglect of cleanliness of mouth, collections of tartar, and the presence of abnormal saliva.

Aural affections that have arisen from the sympathetic irritation of the first dentition are, in many instances, no sooner cured than they are again aroused into sudden activity by the cutting of the second teeth, the eruption of each tooth often being the signal for an earache and subsequent otorrhœa.

During the period of the eruption of the second teeth the education of the child begins, and to the mental strain to which he is often subjected at this period of life, the general nervous exhaustion so often seen is due. Thus run down from mental overwork and the irritation in the jaws, he is much more subject to catarrhal invasions of the air-tracts, and of the middle-ear particularly, because of its liability to reflex hyperæmia. There are but few persons who pass through the period of childhood without having at some time experienced an earache from this source.

The Wisdom Teeth.—These usually erupt between the sixteenth and eighteenth year, but they often are delayed for five or ten years, and those of the lower jaw in many instances come into place with great difficulty even when erupted earlier. The wisdom teeth sometimes remain beneath the gum during life, the natural expulsive force having,

seemingly, become exhausted. They very often are found in the lower jaw in a partially erupted state, presenting their crowns against the neck or crown of the adjacent second molar tooth, and being urged onward in the process of erupting, cause very great irritation. Sometimes the coming of these teeth gives rise to prosopalgia, abscesses in the gums, inflammation of the tonsillar region, and even necrosis of the jaws ultimately. The author has seen cases of protracted tonsillitis and also inflammation of the connective tissue of the pharynx generally from this cause, where irritation about the erupting tooth itself was not a marked feature and was liable to be overlooked entirely.



FIG. 18.—LOWER JAW OR INFERIOR MAXILLA, FROM A SPECIMEN IN THE AUTHOR'S POSSESSION.

The figure shows the horizontal position of the lower wisdom teeth, the position which gives rise to their difficult eruption. 1, The right wisdom tooth, which is wedged in between the ramus, or upright portion of the jaw, and the second molar tooth; it has not, as yet, been able to leave its socket and cut through the gum. As the tooth is urged onward in the effort to erupt, it is forced against the sensitive root of the neighboring tooth, the pressure giving rise to much irritation. 2, The fully erupted left wisdom tooth; it is inclined toward the first molar; the second molar on this side having been lost, room was afforded this tooth to cut through the gum.

Some of the most protracted and intractable cases of acute purulent inflammation of the middle ear that the author has ever seen have been associated with the cutting of a wisdom tooth, the reflex dental irritation keeping up the aural trouble.

In consequence of the less marked aural irritation excited through nervous sympathy in the more protracted cases, subacute and chronic catarrh of the middle ear, giving rise to extreme deafness, may come

on so gradually that the patient is unaware of its existence until its progress has been marked.

Cases are recorded where these teeth have made their appearance in persons as late as sixty years of age. Should the throat be involved, as indeed it is likely to be, in these cases of difficult dentition, the ears will be found to be affected through other channels than the irritation of the dental filaments of the fifth nerve, for the pharyngeal and tonsillar branches of the eighth cranial nerve will bring the throat into direct relationship with the sympathetic system through which the ear is affected.



FIG. 19.—FRONT VIEW OF PLASTER CASTS REPRESENTING THE TEETH OF A BOY AGED SEVENTEEN.

Reflex aural irritation long continued may establish an inflammation the etiology of which will be obscure, especially if the patient has been exposed to well recognized causes of aural disease, unless the part taken by the teeth be kept in mind. The pain of the teeth, which we familiarly associate with their inflammatory condition, is signally absent in many of their affections, and it is the absence of this symptom that gives rise to the chief cause of danger.

The buccal mucous membrane, likewise, becomes diseased from the sharp points of the teeth, which cause its ulceration. Alveolar abscess, affections of the antrum of Highmore and nose are common

occurrences in consequence of death of the pulp of the teeth. Irritation from concealed fangs, left on extraction, or after decay of the rest of the root, is frequent, and from this source irritation or neuralgias arise, in which the ear participates in numerous instances.

The presence of collections of tartar gives rise to irritation, as may be seen by the denudation of the roots of teeth which they occasion; a line of gum much redder than normal may thus be formed, and, in numerous cases, the gums around temporary or permanent teeth finally take on a suppurative action. Crowding of irregular teeth also gives rise to nervous irritability.

From the writer's own observations, he is convinced that the result of transmitted irritation of the dental filaments of the fifth pair to the aural region often gives rise to diseases of the external auditory canal, as seborrhœa, diffuse and circumscribed inflammation, as well as inflammation of the middle ear. It should be stated, furthermore, that, according to Burnett,[1] reflex ulceration of the canal from these causes is not an uncommon occurrence. In one instance, the impulses transmitted to the ear may give rise to otalgia, whilst on the other hand, their long continuance may cause vessel dilatation and consequent congestion in the nutrient tract, ultimately giving rise to progressive trophic changes, in their nature chronic. It is a significant fact that the sympathetic aural affections of infancy and youth are principally confined to the middle ear; and it should be borne in mind that the entire nervous distribution for the milk teeth, together with their alveoli, etc., give way to another development belonging to the teeth that are destined to be permanent.

Dental Plates and Fillings.—It has been endeavored in the foregoing pages to show in a general way some of the injurious influences that diseased teeth have on the ear. It now remains to consider the no less important ones that arise from the attempts made to preserve them, or replace them when lost, by artificial devices. Cavities in the teeth are filled with a variety of substances when the ravages of caries become manifest. The most universally used filling, excepting perhaps gold, is an amalgam consisting of about two parts of tin, one of silver, and as much mercury as will cause the mass to adhere together. This amalgam, composed so largely of mercury, is usually much exposed to the attrition of mastication and the movements of tongue and cheeks. Fillings badly adapted, or where much oxidized by exposure, are liable to produce harmful results. The free mercury which this amalgam contains is worn off in small par-

[1] Treatise on the Ear, Philadelphia, 1884, page 300.

ticles by the friction of the mouth. These particles, when submitted to dilute hydrochloric acid, yield a chloride of mercury. That toxic effects may result from wearing a considerable number of these fillings in the teeth is to be feared. Of fillings in general, it may be said that, not unfrequently, necrosed matter or a diseased dental pulp are covered up with fillings, inducing great irritation from the confined products of inflammation or decomposition. Mechanical appliances to the teeth are not always intended solely to serve the purpose of stopping cavities, for mechanical skill, in a certain branch of dentistry, has made it possible for the operator to permanently attach gold or amalgam mounts to teeth in such a manner as to supply very useful substitutes for the crowns which have been destroyed by caries. Dental artifices are not altogether harmless, when continuously worn in the mouth, especially by run-down or nervous subjects, since they often give rise to much irritation. Whilst the author does not recommend that all pulpless ("dead") teeth should be removed, he still believes that in many instances, perhaps in the greater number, they cannot be retained without injury to the patient; in his aural practice, he has observed a great many recoveries quickly following the removal of defective teeth.

Artificial teeth are worn by an exceedingly numerous class, and it is believed that health often is imperilled by the material used in the construction of plates, as well as from illy fitting them to the mouth. This subject, therefore, should be of interest to the profession at large, as well as the specialist. Plates, especially the vulcanite, are frequently put into the mouth over carious fangs, inflamed gums, and collections of tartar, completely incasing diseased structures, and thereby retaining the foul secretions and decomposed particles of food usually present. Upper plates are especially obnoxious under these circumstances. Many cases have come under the observation of the author, where dentists have recommended them to wear their plates day and night, in order to accustom themselves to their presence; and where plates have been inserted in the mouth as soon as the defective teeth were extracted; these plates are constantly found in the mouth as described above, without pain or apparent inconvenience to the wearer, owing to the tolerance acquired by long use. That septic poisoning may occur from absorption when pus is confined beneath dental plates is possible.

Gold, platinum, and vulcanite are the principal substances used in the construction of plates. Silver and celluloid are also used sometimes. Vulcanite plates produce diseases that are more frequently the source of reflex aural troubles than any of the others

worn. The constituents of this material are caoutchouc, the sulphur required in the vulcanizing process, and vermilion or the sulphide of mercury, used for the color it imparts.

Experiments show that this plastic substance, before it is submitted to the vulcanizing process, when chewed for several hours, is so much broken up that it parts with the vermilion, and that when the saliva of persons thus chewing it was treated with a suitable reagent, it yielded a salt of mercury. Vulcanite is a non-conductor of heat, and the effect of its contact with the highly sensitive tissue of the mouth is often to produce hyperæmia and inflammation. When the plates are worn day and night, of course their injurious effects are much greater. Celluloid has been brought forward as a substitute for vulcanite in the construction of plates, but this substance has not been adopted to any great extent. That all of the morbid conditions of the mouth above described may exist without serious or recognizable aural affection cannot be denied; but progressive disease of the ears, often without the occurrence of pain, is, in the author's experience, more common when these oral affections are present than when the mouth and throat are in a healthy state.

These conclusions of the author are drawn from the carefully recorded observations of some eighteen hundred cases of aural disease, in which the symptoms of reflex irritation from diseased teeth were especially severe. The table below gives the ages and sex of these cases.

Age.	Males.	Females.	Total.
Under 3 years	30	25	55
3 years to 6 years	20	45	65
6 years to 12 years	91	115	206
12 years to 21 years	144	137	281
21 years to 40 years	394	311	705
40 years to 60 years	230	169	399
Over 60 years	59	29	88
Total	968	831	1,799

As will be observed in the above table, but 55 cases were under 3 years of age. It will be proper to state here that all the cases above given were such in whom the symptoms were very marked, and of which it was deemed advisable to keep a record. The ages and sex of the 55 cases under the age of 3 years were as follows:

Age.	Males.	Females.	Total.
7 months and under	6	2	8
8 months	3	..	3
9 months	1	1	2
10 months	..	1	1
11 months	..	2	2
Between 1 and 2 years	11	10	21
Between 2 and 3 years	9	9	18
Total	30	25	55

Among the aural diseases associated with these cases of diseased teeth, due undoubtedly in a great measure to reflex irritation from this source, were 93 cases of acute, 33 of subacute, and 688 of chronic catarrhal inflammation of the middle ear. There were 235 cases of acute, 4 of subacute, and 401 of chronic purulent inflammation of the middle ear. Of diffuse and circumscribed otitis externa (furunculosis) there were 102 cases, and 340 cases of large accumulations of cerumen, 41 cases of seborrhœa, and 24 cases of eczema. There was severe purulent inflammation of the middle ear involving the mastoid cellules, etc., in 26 cases. In 953 cases there was marked catarrh of the upper air tract, this group including also a considerable number of cases of enlarged tonsils, 52 cases of alveolar abscess, and 21 cases of ozæna. The tendency to catarrh of the entire upper air tract is doubtlessly much increased in persons having defective teeth.

Of 189 dental plates worn by these patients, 178 were composed of vulcanized rubber, 3 of gold, 3 of platinum, 1 of silver, 4 of celluloid.

A table of the ages and sex of patients wearing vulcanite plates given below.

Age.	Males.	Females.	Total.
Under 20 years	1	5	6
20 to 30 years	10	36	46
30 to 40 years	11	31	42
40 to 50 years	10	32	42
50 to 60 years	9	16	25
Over 60 years	8	9	17
Total	49	129	178

Of the 11 remaining cases where other kinds of plates were worn, 2 were males, 9 females.

It is often urged as a reason for wearing artificial teeth or retaining dead teeth by filling more or less completely the pulp chamber and fangs of teeth, that the absence of even a few teeth prevents the thorough mastication of food, and that its digestion is thus interfered with. The importance of the teeth in this respect is greatly overestimated, as the many changes in the kinds of food and their preparation in the present state of civilization have very materially lessened the necessity for mastication by the teeth. These plates are very commonly worn by persons among the serving class, who plead in excuse that it is difficult, if not quite impossible, to secure situations on account of their personal appearance where the front teeth are absent. Their means do not admit of the purchase of other than cheap and ill-fitting false teeth, which are very often positively injurious to the wearer.

The harm liable to result from the retention of dead teeth in the mouth cannot well be exaggerated, especially where the nerve cavities are stopped, and no vent exists for the escape of accumulations which form in them. The retention of pulpless teeth should be avoided, especially in persons wanting in nervous tone. The constant hyperæmia thus often kept up in the organ of hearing by reflex oral irritation renders the ear less able to withstand the influence of other active outside agents and more prone to disease; for example, it was found that among the very considerable number of cases of oral irritation observed, in 79 having very much decayed teeth, the direct cause of the ear trouble was due to getting water in the ears while bathing in the sea, in one instance to fresh-water bathing, and in another to a shower bath. It was noted that severe neuralgia was present in 179 cases, pronounced nervous irritability in 21 cases, nasal and other reflex phenomena in 20 cases, and severe otalgia in 59 cases.

CHAPTER VIII.

Bathing in the sea. Fresh water bathing. Russian, Turkish, and other baths. Entrance of water into the ears by the use of the Nasal Douche, Post-nasal syringe, Sniffing up of water, etc. Clipping and wetting the hair of the head.

INJURY TO THE EAR FROM BATHING.

The entrance of water into the ear was known to be injurious by the ancients, since Avicenne, a Persian physician of the tenth century, enumerates among the causes of aural disease "getting water into the ear."[1] It is a matter of surprise that such a common source of ear trouble should have attracted so little attention among modern writers, especially those living near the ocean, where large numbers of persons go into the water daily during the bathing season. But before entering into an account of the manner in which the ears of bathers are affected, it will be of interest to consider the construction of the ear in animals living a portion of the time submerged in water, A large number of marine quadrupeds may be included in this class. such as the crocodile,[2] seal, hippopotamus and the like. These can remain under water a long time before coming to the surface for the purpose of breathing, and it is found that the construction of their ears is such that no damage occurs to the organ from frequent excursions into the water, which is frequently colder than the atmosphere as well as irritating to delicate structures. A study of the *hippopotamus amphibius*, or river-horse, in this regard is instructive. The author has often observed this pachydermatous monster during his aquatic sports in the large tank of water provided for his use at the Zoological Garden in Central Park. When inclined to retire into the aqueous element, the animal's body first disappears, leaving the head in view. If his actions be now closely observed, it will be seen that the ears, eyes, and nostrils, which lie on about the same plane,

[1] Works of Avicenne. Basle, 1556.
[2] Miall: The Skull of the Crocodile. Macmillan & Co., London, 1878.

are immersed at nearly the same moment. As the head is gradually lowered the auricle is given a twist and drawn down closer to the head; the eyes are then closed and, finally, as the nose goes under, the nostrils are closed by the action of a sphincter muscle. When the animal comes to the surface again, the nose first appears and an expiratory effort takes place, blowing a little moisture from the parts; the eyes are opened again, and the auricles are brought smartly up, opening the external meatus and throwing a gentle spray from their surface. These functions are seemingly performed automatically. Some of the animals of this class are provided by nature with a movable membrane which can be drawn over the ears when diving under water, and they always close the mouth and nostrils. The water-shrew is said to protect the ears, when pursuing game into water, by closure of the meatus, which is accomplished by muscular force exerted in such a manner as to also draw the meatus inwards. The auditory apparatus of the whale is said to be protected by the smallness of the external auditory meatus, which begins externally with a narrow opening, and finds its way to the drum by a long, tortuous, tubular passage. It has been alleged[1] that it is impracticable for sound vibrations to reach the drum-head through a canal so narrow; that indeed the drum-head is convex outwardly—the opposite condition to that in man and other mammalia—whilst the Eustachian tube is so large as to suggest the entrance of sound through the mouth when open; the author, however, doubts the correctness of the foregoing conclusion.

Some of the lower orders of marine life, living exclusively in water, have no special auditory nerve, but receive sound impressions by means of shock imparted to the body.

The tympanic membrane and other parts necessary to sound transmission in mammalia are said to be absent in snakes and many saurians, though lizards and frogs have an exposed drum-head. Moles are said to have a closed external auditory meatus which excludes earth in burrowing;[2] and the camel when exposed to the sand laden simoon of the desert has the ability to contract the nostrils at will.

It will be seen from the foregoing that the ears of amphibia are naturally adapted to the circumstances of their environments. Man, however, unlike amphibians, has not the peculiar anatomical structure, by means of which water may be automatically shut out from the auditory apparatus when his head is submerged, and the fre-

[1] Pilcher.

[2] Bergman and Leuckart: Vergleichende Anatomie und Physiologie. Stuttgart, 1852.

quency of aural disease from bathing, especially in the ocean, justifies the considerable space which will be devoted to the subject here.

Bathers in the surf are liable, when off their guard, to be struck by the waves upon the ear with much violence, especially in boisterous water at full tide. Cold salt water may thus enter the external auditory canal with sufficient momentum to rupture the drum-head in persons having a large, freely open canal. Swimming or floating upon the back, especially the latter, when the ears are submerged, or diving and swimming beneath the surface, often exposes the ears very much to the entrance of water. Long exposure in this manner, and indeed, sometimes from a bath of short duration, frequently gives rise to inflammation of the external auditory canal or the drum-head, or of both. In a considerable number of cases the middle ear is also invaded. Some of the more severe cases of otitis media arise from the long retention of cold and irritating salt water in the external auditory canal, the inner end of the latter, from its more dependent position, affording lodgment for the same. Every bather has experienced the disagreeable sensation arising from "getting water in the ears," which is not always removed by jumping about on one foot with the ear held downwards. The cold water of the sea is especially obnoxious because of its comparatively uniform low temperature and the large quantity of chloride of sodium which it holds in solution; it thus injures the ear by a direct cooling effect as well as by its highly irritating character.

When the face is struck by a violent wave, the water sometimes has sufficient momentum, after entering the open mouth or nostrils, to force its way along up the Eustachian tube to the middle ear. The violence of the impact of an ocean wave cannot be fully appreciated by any one who has not felt its force; it is often sufficient to knock the most sturdy bather off his feet and mercilessly toss him about in the sand and foam of the breakers. The author's own experience in rough water has very much impressed him with the danger to the ear from this cause. Persons unguardedly sporting in the water are never free from danger in this regard, and in diving or struggling in the surf may take into the mouth or nose a large enough quantity of water to cause strangling, the act being accompanied by the transmission of more or less water into the drum of the ear. The habit of standing in the cool wind while the body, and especially the hair of the head, is allowed to slowly dry by evaporation, is reprehensible, as is also the practice of blowing the nose forcibly with a view to clearing its passages of sea water; the former is liable to invite head colds, the latter may force sea water into the drum.

Men are much more exposed to the causes above mentioned than are women.

The following tabulated list of 273 cases of aural disease arising from salt-water bathing shows the sex of the patients and also the ages in which these troubles are most liable to occur.

Age.	Males.	Females.	Total.
Under 5 years	..	1	1
Between 5 and 10 years	2	..	2
Between 10 and 20 years	112	9	121
Between 20 and 30 years	77	12	89
Between 30 and 40 years	31	6	37
Between 40 and 50 years	17	..	17
Over 50 years	4	2	6
Total	243	30	273

That the entrance of cold salt water to the ears is unpleasant goes without saying, and often there is no other effect. But inflammation of the external auditory canal is a frequent result, and the drum-head is yet more liable to become inflamed, because of its greater delicacy. No serious inflammation of the latter ever takes place without involving the drum cavity itself. The attic of the tympanum frequently becomes involved from the entrance of water via the Eustachian tube, and in some instances doubtlessly the drum is affected both from without and from within at the same time. Where the bather's ears contain an accumulation of cerumen, this is liable to saturation or displacement by the force of entering water, and when impaction takes place very distressing symptoms occur.

The following is a summary of the aural diseases and complications of existing diseases for which these patients applied for treatment:

Acute purulent otitis media,	69 cases.
Chronic purulent " " (from repeated exposure in bathing),	64 cases.
Acute catarrhal otitis media,	40 cases.
Subacute " " "	3 cases.
Acute exacerbation of existing chronic purulent otitis media,	3 cases.
Otitis externa diffusa,	46 cases.
Otitis externa circumscripta,	5 cases.
Otitis externa exudativa,	2 cases.
Myringitis (either independently or in connection with inflammation of the external anditory canal),	30 cases.
Impaction of cerumen,	16 cases.
Otalgia due to exposure, etc.,	3 cases.
Aggravation of symptoms arising from chronic catarrhal inflammation by abuse of sea bathing (bathing frequently and remaining in the water too long),	47 cases.

It was noted that in many of the cases where injury to the ear arose from water being driven into the meatus with great violence, injuring the drum-head and even the walls of the canal by mere force of impact, the canals were of larger calibre than ordinary; in fifty-seven of the cases where the size of the canal was noted, they were much larger than normal. It is often found that patients have had repeated and severe inflammatory ear trouble from bathing, before coming for treatment.

Fresh-water Bathing.—The effect of fresh-water bathing upon the middle ear and surrounding parts is the same as that of salt-water bathing, but in a less degree, injury doubtless occurring in a similar way from diving and sporting in the water. In seven of the author's cases of aural disease from this source, four were suffering from acute purulent inflammation of the drum, two from chronic purulent, and one from chronic catarrhal inflammation of the middle ear, aggravated by the bathing.

Russian and Turkish Baths.—Acute inflammation of the middle ear, etc., is liable sometimes to occur after the use of these baths, which render the patient extremely susceptible to cold and consequent catarrh of the upper air passages. In seven cases of persons in the habit of taking Russian baths coming under the writer's observation, there was one with acute purulent otitis media, four with acute otitis externa diffusa, extending in two patients to the drum-head, which was also in a state of inflammation. The drum was also probably affected in these cases. One patient finally was suffering from chronic catarrh of the middle ear, induced and aggravated by the habit of taking these baths for a period of many years.

The author reports also four cases of aural disease resulting from long-continued indulgence in the Turkish bath. Two of these patients had chronic purulent otitis media, and one chronic catarrh of the middle ear, whilst one patient was suffering from acute inflammation of the canal.

Six cases of acute purulent inflammation of the middle ear, resulting from the effect of getting water in the ears or from the susceptibility induced by baths of various kinds, were recorded:

A shower bath	in 1 case.
Hot-water baths	in 2 cases.
Hydrant water falling in the ear	in 1 case.
Exposure after ordinary bath	in 1 case.
Bathing when overheated	in 1 case.

One patient, a male 40 years of age, who was suffering from chronic catarrh of the middle ear, attributed a marked increase of tinnitus aurium to taking a cold bath.

The consequences of aural disease arising from sea and other kinds of bathing do not differ greatly, of course, from the same affections brought about by other causes. In many instances, the course of middle-ear inflammation from bathing is attended by intense pain, and a chronic discharge of an irremediable nature is often left as a legacy.

ENTRANCE OF WATER INTO THE EARS BY USE OF THE NASAL DOUCHE, POST-NASAL SYRINGE, SNIFFING UP OF WATER, ETC.

That water and other fluids may enter the middle ear by way of the Eustachian tubes, causing often very serious disturbances of that organ, is well known.

The use of the nasal douche, now unfortunately well established in domestic practice, is exceedingly liable to injure the ears by the transmission of the fluids used to the drum cavity. From among the numerous instances of this description occurring in the practice of the writer, the following summary it is believed will be of especial interest here.

In eight cases, the prolonged use of the nasal douche caused aggravation of chronic catarrhal otitis media; in seven patients, chronic purulent inflammation of the middle ear remained as a result of acute processes. Six persons applied for treatment suffering with acute catarrhal, and seven with acute purulent otitis media, induced, in all cases, by the abuse of this apparatus.

One case of injury to the ears from blowing spray through the nose under high pressure came under observation, and one case, that of a young girl who was troubled with the sensation of pressure in her ears after using the nasal spray. This was without doubt due to the presence of water forced into the drums. There were four persons, furthermore, suffering from autophonia, tinnitus, etc., owing to the employment of the nasal douche; one of these patients employed a cold solution of carbolic acid, glycerin, and salt.

Snuffing water, or remedies in solution, up the nose is not free from the same danger that attends the use of the above-named apparatus.

The writer has observed a number of such cases. Thirteen persons applied to him for treatment of aural diseases incurred from snuffing up *cold salt water*. Several of these patients had the habit of per-

forming the Valsalvan experiment, or blowing the nose violently after the use of this fluid. In nine of the cases, this procedure was followed by an attack of acute catarrhal otitis media; in three by acute purulent inflammation, and in one by chronic catarrh of the middle ear. Snuffing up of *cold water* produced aural disease in four persons; namely, in three, chronic catarrhal, in one chronic purulent inflammation.

The snuffing up of *alum water* induced catarrhal inflammation in the middle ear in two cases, with accompanying tinnitus and increasing deafness; one of these persons, in endeavoring to force the water out of his ear by violently blowing the nose, had ruptured the drum head. Still another patient applied for treatment with a bad attack of acute purulent otitis media of both ears, caused by snuffing up of *warm sea water*. The water was felt to enter the ears on several occasions, giving rise to rumbling noises and pain. The records of the author show, furthermore, one patient suffering from acute purulent middle-ear inflammation caused by use of the post-nasal syringe, and two cases of persons troubled with tinnitus and a "sensation of pressure in the ears," both of whom were in the habit of performing the Valsalvan experiment, the water probably being forced into the drums by this procedure. One patient, furthermore, was troubled with autophony, to relieve which he had long been in the habit of sniffing up water into the nose. In another case, the existing aural disease was seemingly much increased by the constant use of snuff.

In conclusion, it should be remarked that it is not unlikely that the mother's milk, flowing freely into the nursling's mouth, causing strangulation, is sometimes forced up along the Eustachian tube into the tympanic cavity; and this accident would be still more likely to occur where the infant was fed from a free-flowing bottle while lying on its back.

CLIPPING AND WETTING THE HAIR OF THE HEAD.

Closely cropping of the hair of the head, especially its removal from the parts immediately back of the ears, is often seemingly a cause of inflammation of the middle ear. This is obviously more likely to occur among males than females, the latter rarely having the hair cut off.

Among eleven cases of this kind, where clipping the hair gave rise to cold in the head and consequent aural inflammation, but one patient was a female, a child of six years of age. Three of these patients were suffering, when seen, from an attack of acute purulent otitis media; six had acute catarrhal inflammation of the middle ear;

in one patient the drum-head was the seat of inflammation, in another there was diffuse inflammation of the external auditory canal.

The custom of shampooing or washing the hair of the head and allowing it to dry slowly may, in a like manner, give rise to ear trouble. Females with a heavy growth of hair are especially liable to be affected from this cause. Very grave cases of purulent inflammation have resulted from these practices. Among six cases of females with aural troubles arising from such sources, there was one case of acute catarrhal, three of acute purulent inflammation of the middle ear, whilst two patients were suffering from acute exacerbations of chronic purulent otitis media. One of these persons, a girl of ten years, had had her hair cut a month previously, since which time she had the habit of holding her head daily under the hydrant "to keep the hair smooth." Such cases are frequently met with, but so universal is the practice that but few are ever inclined to really estimate the risk incurred thereby.

One of the most severe and intractable cases of acute purulent inflammation that has ever been seen by the writer occurred in a lady who exposed her head to the cold air while out driving, before the hair had been allowed to dry after being washed.

PART THIRD.

WOUNDS, INJURIES, AND DISEASES OF THE EAR, AND THEIR TREATMENT.

CHAPTER IX.

WOUNDS AND INJURIES OF THE EXTERNAL EAR.

Cleft of Lobule. Othæmatoma. Gunshot, Sabre, and Arrow Wounds.

The pinna, or wing of the ear, consisting, as it does, of a delicate cartilaginous framework, occupying a prominently outstanding position, is very much exposed to injuries from blows, delivered either accidentally, as in boxing or in play, or from falls upon the organ. Even lying upon a hard pillow may, especially under favorable conditions, to be alluded to further on, set up inflammatory action in the auricle, the injury in either case resulting from the auricle being more or less forcibly pressed against the head and unyielding temporal bone. That the auricle is not more frequently the seat of disease from these causes may create some surprise, when it is considered that the perichondrial envelope which everywhere lies in contact with the cartilaginous framework is so frequently liable to trauma, and its consequent separation from the cartilage through inflammatory effusion so often follows, as will be seen under *othæmatoma*. The exterior ear is, furthermore, liable to gunshot and sabre wounds, the former occurring in warfare and also civil life, as the result of suicidal attempts or accidents. The lacerated, contused, incised, and punctured injuries resulting especially from gunshot wounds, may affect the outer organ only, but they very often involve the middle ear mechanism or other parts of the ear contained in the temporal bone. Since, therefore, all the anatomical parts of the ear are extremely liable to be included, their classification as external, middle, or internal ear wounds or injuries, cannot be made conveniently in all cases.

CLEFT OF LOBULE (FROM EARRINGS).

One of the most frequent wounds of the auricle occurs in the lobe, and is produced by the fine wire of earrings gradually cutting its way through the soft tissues, owing to the weight of the pendant, or from

being torn out suddenly. In some cases the wire seems to cut its way through so rapidly as to be followed by healing, a cicatricial line being thus left in its wake. When several parallel lines are thus formed, the point of exit gives a serrated look to the border of the lobule. The loose tissue composing the lobule sometimes breaks down very rapidly under the inflammation excited by piercing and the subsequent introduction of earrings.

Among such cases coming under the observation of the author, and being especially noteworthy as occurring in sisters, are two, where the same rings, both of 14-carat gold, were used. In both of these children the rings soon cut their way out, and even a portion of the lobule sloughed off. The accident could not be altogether attributed to the base metal of which the rings were made. The lobules, in such cases where these injuries are apt to occur, will generally be found very thin.

Treatment.—An operation for the relief of the deformity when a slit remains in these cases is sometimes required. Such an operative procedure consists in paring the edges of the notch with a small scalpel, but leaving a portion of the posterior paring, a few lines in length, attached when cutting off the slice, as suggested by Knapp,[1] after the Mirault-Langenbeck operation for hare-lip. This remaining fragment, when the raw edges of the two sides have been brought in contact with each other, is made to overlap and attach itself to a denuded surface on the opposite side of the notch, thus preventing the occurrence of any gap on the margin of the lobule after healing.

OTHÆMATOMA.

Synonym.—Hæmatoma auris; Perichondritis Auriculæ.

Hæmatoma auris is a disease of the cartilage and perichondrium of the auricle, with consequent formation of a cyst containing blood or varying portions of its constituents.

The ancients were very familiar with this morbid condition of the auricle, since it was the necessary result of boxing-matches, which then constituted the favorite mode of combat. Among the Greeks and Romans pugilism was considered an essential part of education, as it increased the strength and developed boldness of character in their youth. Defence and assault with the fist or cestus were then extremely common, and combats for amusements even were the fashion of the day; the Grecian boxers, who were justly renowned, had for

[1] Archives of Oph. and Otol., vol. iii., pp. 254–256.

their titulary deity Pollux himself. The Æneid abounds in praise of these barbaric contests; thus in the combat between Eutellus and Æneas—

> "A storm of strokes, well meant, with fury flies,
> And errs about their temples, ears, and eyes —
> Nor always errs, for oft the gauntlet draws
> A sweeping stroke along the crackling jaws."

The implement employed by the classic slugger in these auricle-cracking feats was the cestus, a formidable gauntlet composed of thongs of several thicknesses of raw hide strongly fastened together and loaded with lead, iron, or brass, and bound to the arm by thongs. Four varieties of this crushing implement are known to have been in use, the least deadly being more dangerous even than the modern assassin's "brass knuckles," and capable of administering a fatal blow. These murderous weapons were known to Virgil as the "gloves of death." Paulus Ægenita refers to the aural injuries produced by this weapon as contusions of the ear, and Hippocrates described them as fractures of the auricle, adding that the injury was a common one in his day. "The combat with the cestus," he says, "was a favorite amusement of the ancients, and a blow about the ears was reckoned a masterstroke, sometimes being fatal." At a later date the amphotides, a helmet or headguard, was worn to protect the temporal bones, arteries, and ears. It was constructed with thongs and ligatures made of the hides of bulls, studded with knobs of iron, and thickly quilted inside to dull the concussion of blows. The pugilists and the pancratiastes, armed with the cestus, were in the habit of producing such disfigurement of the ears that it became a customary plastic ornament in antique sculpture, which thus affords abundant evidence of the results of these practices; for example, the heads of Hercules, Pollus, Hector, and other warriors have been represented with ears having this typical deformity of ancient contestants.[1]

The ancient custom of boxing has been continued by the Anglo-Saxon race, especially in Great Britain, where for a long time past it has been encouraged as a national amusement and has a literature of its own. During this period of time, however, the unprotected fist has been employed in combat, and the occurrence of the more serious aural injuries has in consequence diminished. Pugilism has now everywhere fallen into disrepute, and its votaries are principally confined to low resorts, where the boxers enter the lists with gloved fists

[1] Vide Gudden: Hæmatic Swelling of the Ears of the Insane. Allg. Zeit. für Psychiatrie, Bd. xvii. Med. Critic, January, 1861. Ranking's Abst., vol. i., p. 43, 1861.

and go through the forms of a "mill" for the amusement of the audience. Even here, however, we find that some vigorous blows about the head are demanded, and the ear is frequently struck, especially in "cross counter," in which the left ear suffers most. The frequent pounding of the left auricle in this manner often gives rise to othæmatoma. A very considerable number of persons are at present engaged in this occupation for a livelihood, and most of them have characteristically deformed auricles.

The tendency to violent contests has shown itself in other pastimes where the ear does not always escape injury; thus Farquharson[1] describes several cases of the disease under consideration, coming on suddenly, with oval swelling of the auricle, as a consequence of playing the game of foot-ball at Rugby, where there is much forcible butting with the head in "tight scrimmage."

Etiology.—Of purely traumatic othæmatoma no mention need be made here, but in regard to the origion of the so-called idiopathic or spontaneous variety there has been much difference of opinion. The first description of othæmatoma, in which mental and other nervous disturbances play so important a part, was published fifty years ago by Dr. Friedrich Bird,[2] then connected with the asylum at Sieburg. Bird gave a very good account of six cases coming under his observation, and drew attention to the intimate relations of the disease to insanity. He was, however, at a loss to account for its origin, having never traced it to outward injury, but in five of his cases it is noted that there was active congestion of the head. The suggestions thrown out by Bird finally received the attention of other writers: M. Ferris, a Frenchman, gave the subject his attention in 1838, and ten years later (1848) the valuable essay on the subject by Franz Fischer[3] was written. The observations of alienists were naturally limited to the occurrence of the disease in insane persons; in 1859, however, an Englishman, Mr. S. Ozier Ward, drew attention to the liability of the mentally sane to the trouble.[4]

Numerous contributions have been made to the literature of the subject during the past thirty years. In 1858 an interesting paper

[1] British Medical Journal, Vol. ii., p. 59, 1873.

[2] Upon a Curious Sort of Inflammation of the Outer Ear Occurring in Insane Patients. Friedrich Bird. Graefe's and Walther's Journal, B. 19, p. 361. See Am. M. Ch. Rev., Vol. xxiv., p. 201, 1834.

[3] Die Ohrblutgeschwulst der Seelengestörten, nebst einer Beobachtung der Kopfblutgeschwulst bei einem solchen Kranken. Allg. Ztschr. f. Psychiat., 6te Band, 1849, v. 1. Also Dr. Arlidge's translation, Asylum Journal, 1854, pp. 33-107.

[4] Medical Times and Gazette, Vol. ii., p. 305, 1853.

was published by Stiff, "On Simple Sanguineous Cyst of the Ear in Lunatics,"[1] and in 1859 the distinguished labors of M. A. Foville were made known.[2]

It will be found on consulting the "Index Catalogue of the Library of the Surgeon-General's Office"[3] that, although incomplete as yet in respect to this subject, fifteen monographs and forty-six journal articles and other papers pertaining to othæmatoma were published between the years 1848 and 1879 by German, English, Italian and American authors.

One cannot witness the intense congestion of the ears, sometimes accompanying great cerebral excitement in the insane, without belief in the possibility of spontaneous extravasation of blood taking place beneath the perichondrium; and it would seem possible that where tissue changes, to be immediately referred to, have already taken place in the cartilage and perichondrium, othæmatoma may sometimes thus occur. These nutritive changes in the auricle, believed to pave the way for extravasation, so to speak, will first demand our attention. They seem to be mainly brought about through the agency of the nervous system, although some authorities lay much stress on the influence of blood dyscrasias in producing changes in the blood-vessels of the part. The weight of evidence, however, leads to the conclusion that they most frequently depend on a morbid state of the brain, especially on congestion of the organ. Functional disturbance of the brain, or of the cerebro-spinal centre, giving rise to disorder of the cervical sympathetic, may, by reason of the dominance thus exercised on the vessel regulating nerves distributed to both intercranial ganglia and the auricle, set up hyperæmia in the former, and vascular changes in the latter.[4] When othæmatoma occurs in the course of genera paralysis, it would seem that aural congestion took place in consequence of general degeneration of the sympathetic; and it has been suggested that in inflammation of the brain the aural disease becomes advantageous to the patient, since the hemorrhage is thus spent upon the posterior auriculars, coming from the middle meningeal.[5]

[1] B. and F. Med. Chir. Rev., Vol. xxi., pp. 169–174. Am. Ed., 1858.

[2] Recherches sur les tumeurs sanguines du pavillon de l'oreille chez aliénés. Ann. Méd.-psych., Par., 1859, 3. S., v., 390–408. Also: Gaz. hebd. de méd., Par., 1859, vi., 450, 469. Also; transl. Am. J. Insan., Utica, N. Y., 1859–60, xvi., 184–200. Vide also, Hématôme du pavillon de l'oreille chez un aliéné. Union méd. de la Seine-inf., Rouen, 1877, xvi., 24, 37.

[3] Vol. i., Government Printing Office, Washington, 1880.

[4] Vide Robertson, Glasgow M. J., vol. vii., July, 1875.

[5] Bonnet: Annales Médico-Psychologiques, 1877. A. J. O., vol. i., p. 68.

TABLE No I.

Showing the results of an examination of 1,339 female patients in the New York City Lunatic Asylum, Blackwell's Island, January 10th, 1883.

No.	Age	Ear Affected	Nativity	Duration of their present sojourn in the Asylum	Duration of Insanity	General Health.	Diagnosis.	Present Condition of the Affected Ear, and Duration of the Disease.
1	32	Left..	Germany.	3½ years	.....	Good.....	Chronic melancholia. Patient is violent.	The affection seems to have existed for some time. The auricle is much thickened, especially the fossæ of the helix and the concha.
2	20	Left..	Ireland...	4½ years	.....	Fair.....	Mania.....	Othæmatoma developed two years ago; is now in chronic state.
3	20	Left..	U. S. A...	2 years..	.....	Has phthisis.	Mania, recurrent.....	Othæmatomatous deformity of long duration.
4	41	Left..	Ireland...	5 years..	.....	Good.....	Secondary dementia. A powerful woman.	Othæmatoma developed suddenly one year ago.
5	30	Left..	Scotland..	8 mos...	2 years..	Poor.....	Intemperate, melancholia with frenzy. Is poorly nourished, and is lapsing into dementia.	The deformity is of long duration.
6	33	Left...	Ireland...	.....	.....	.....	Acute mania, temperate. Pounds her head against wall or floor.	Ear is contracted; cartilage of concha thickened; the skin immovable over the tumor.
7	58	Left..	Ireland...	.....	.....	.....	Chronic mania, temperate. Has been very violent, is now fast merging into dementia.	Cartilage thickened; skin freely movable. Cartilage of right ear is slightly thickened; no history of the attack.
8	35	Both..	Ireland...	.....	5 years..	....	Puerperal melancholia, intemperate. Violent.	Both ears have been the seat of othæmatoma; cartilages of both helices thickened, skin immovable. No history of aural attacks.
9	39	Left..	Ireland...	.....	.....	Fair.....	Chronic mania, intemperate. Her mother was insane. Violent.	Auricle contracted; cartilage thickened. The skin is immovable.

10	31	Both..	U. S. A...	.....	....	.....	Acute melancholia, temperate. Was once violent.	Both ears are affected; cartilages thickened very much; skin immovable.
11	25	Left...	Ireland ...	.....	.....	.....	Chronic mania, temperate. Violent and destructive.	Cartilage thickened. No history.
12	50	Left...	Ireland ...	.....	.....	.....	Epileptic mania, temperate. Violent.	Auricle shrivelled up, of a reddish color. No history of the othæmatoma.
13	..	Left ..	Ireland ...	.....	.....	.....	Mania. Violent only at times.	Auricle much deformed, thickened; meatus externus narrowed; both ears are red; skin adherent in left. There has been a discharge from both ears for fifteen years.
14	..	Left ..	Ireland ...	28 years	.....	.....	Mania. Has been violent.....	Long standing othæmatoma; marked thickening. The superior portion of the auricle much deformed. Patient states that it came from a blow in a fight. It is more red than the right ear. The skin is immovable.
15	32	Left ..	Ireland ...	About 5 years.	.....	Fair.....	Dementia, intemperate.....	See Case X. (page 145).
16	30	Left ..	.....	4½ mos..	.....	.....	Melancholia, acute.....	See Case VIII. (page 144).

TABLE NO. II.

Showing the results of an examination of 1,296 *male patients in the New York City Asylum for the Insane, Ward's Island, March* 19*th*, 1883.

Number.	Age.	Nativity.	How long insane.	In asylum.	General health.	Diagnosis.	Ear affected.	Hearing affected.	CHRONIC CASES.								ACUTE CASES.				
									Traumatic.	Idiopathic.	Red.	Pale.	Deformity. Superior.	Deformity. Middle.	Deformity. Inferior.	Deformity. Lobule.	Treatment. Pressure.	Treatment. Incision.	Treatment. Antiphlogis.	Spontaneous rupture.	Without treatment.
1	45	Ireland	9 years.	5 years.	Good.	Dem	Left, then right.	Left	..	..	1	..	L ..	1	..	..					
													R ..	..	1	1	..	..	..	..	..
2	43	Ireland	12 years	11 years	Good.	Mel	Left	Not	..	..	..	1	1	..	..	..	..	..	..	.	..
3	32	United States.	8 years.	8 years.	Good.	Dem.	Right	Not	..	..	..	1	.	1	1	..	..	..	..	..	..
4	33	United States.	12 years	11 years	Good.	Dem.	Right, then left.	Not	R ..	..	.	1	1	1	1	..	..	..	..	..	..
									L 1	..	..	..	..	1	..	..					
5	40	Sweden	4 years.	3 years.	Good.	Dem	Left	Not	..	..	..	1	1	1	1	..	..	..	..	..	..
6	60	Germany	3 years.	3 years.	Good.	Dem.	Left	Not	..	..	1	..	..	1	..	..	..	..	..	..	..
7	36	England	8 years.	7 years.	Good.	Dem.	Left	Not	..	..	..	1	..	..	1	..	..	..	..	..	..
8	47	Ireland	5 years.	2 years.	Good	Ch. man.	Left	Yes	..	..	1	..	1	..	..	..	..	..	..	..	..
9	30	Germany	15 mos.	11 mos.	Good.	Ac. man.	Left	Yes	..	..	..	1	.	1	..	..	..	..	..		..
10	52	Germany	.....	6 mos...	Good.	Gen. par.	Both	Not	..	..	..	1	R 1	1	1	1					
													L 1	1	1	1	..	..	..	..	..
11	35	Ireland	4½ years	6 mos...	Good.	Gen. par.	Right	Not	..	..	1	..	1	1	1	..	1	1	..	..	..
12	46	United States.	3 years.	3 years.	Good.	Ch. man.	Left	Yes	..	..	..	1	1	..	..	..	..	..	..	..	..
13	31	United States.	6 years.	6 years.	Good.	Ch. man.	Left	Yes	.	..	..	1	1	..	..	..	..	..	..	..	..
14	33	United States.	3 mos...	½ mos..	Poor.	Gen. par.	Left	Not	1	..	..	1	1	1	1	..	..	..	1	..	..

But while central morbid conditions are justly regarded as of greatest importance, other impressions, propagated by morbid processes in other organs through the sympathetic system, are worthy of consideration; thus, in the examination of insane subjects having this affection, the almost universal prevalence of nasal catarrhs, diseased teeth, and, in the female, of uterine disease, is notable, and it is well known that the irritation due to these influences is transmitted through the nerves, and may not only exasperate cerebral disease itself, but is liable to also affect the organ of hearing.

The *predisponents* believed to have an important relation to othæmatoma require consideration somewhat in detail.

1. *Age.*—Othæmatoma is generally found in adults, although a number of cases occurring in children have been observed and reported by various writers. Langenbeck reports a case occurring in a girl, twelve years of age, who was said to be *wild*. Blau[1] describes a case observed in a gymnast, aged fifteen years, where there was no psycho- nor neuropathic family history. The case had, it is said, no history of trauma, but it is significant that otorrhœa existed. Schwartze has seen a case in a child fourteen years of age, and Julius Erhard[2] speaks of cases arising in nurslings from rough handling or injury, causes from which the writer has never seen the affection arise. If the disease ever exists in very young children, its occurrence seems to be quite exceptional.

A case of othæmatoma occurring a female child, aged two years, was reported by Wiener,[3] and which was considered by that author to be spontaneous in its origin; no history of trauma could be discovered.

In regard to the appearance of othæmatoma in the insane, it may be said that insanity is not obnoxious to youth, nor is degeneration of the cartilage liable to occur at this early age.

Contusion of the auricle may, of course, occur at any age. The disease has not been, to the writer's knowledge, ever reported in extreme old age, which would seem to confirm the view that degeneration in structure alone is not a sufficient cause, but that its occurrence must be looked for in the active period between adolescence and the decline of life.

2. *Sex.*—Writers are generally in accord respecting the greater frequency of othæmatoma in the male. Mr. Nicol,[4] who examined the

[1] Arch. f. Ohrenheilk., B. xix., Hft. 4, pp. 203, 204.

[2] Vorträge über die Krankheiten des Ohres, p. 132. Leipzig, 1875.

[3] Richmond and Louisville Med. Journal, vol. xxii., p. 16.

[4] Othæmatoma, or the Asylum Ear. B. and F. Med. Chir. Rev., No. xci., July, 1870.

ears of a considerable number of the inmates of the Sussex Asylum, found in 24 of them more or less deformity of the auricle, in several of them the disease being in progress. Of the 700 patients in the institution, 2 women only were affected. Of the 249 asylum patients examined by Stiff, viz., 124 men and 125 women, he found the cartilage of the ear more or less thickened in 17, probably the results of othæmatoma; of these, 12 were males and 5 were females. In the six cases reported by Dr. Bird,[1] all of them were females.

Lennox Browne[2] examined 1,424 cases in the West Riding Asylum, 707 of whom were males, and 717 were females. He found that of the 32 patients affected, 24 were males and 8 were females, making 3.39 per cent of the males and 1.11 per cent of the females affected—an average of 2.24 per cent. M. Foville, in alluding to this subject, says the affection occurs most frequently in males. Hun[3] reports 24 cases of the disease, 23 of them being males and 1 of them a female. The writer himself found in the statistics kindly furnished him by the Blackwell's and Ward's Island Institutions for the Insane (see tables I. and II.), that among 1,309 females, 16 cases of othæmatoma were found, while in 1,206 males, 14 cases were found, this inclusive of ears previously affected, as shown by deformity of the auricle, and those in progress at the time the examinations were made.

This shows a percentage of 1.14 in females, and 1.10 in males. It will thus be seen that the greater number of cases occurred among females. The writer, however, would refer here to the table (page 151) of 9 cases observed by him, occurring in mentally sane persons. It will be seen that of this number, but one was a female. In the opinion of some alienists female lunatics are more violent than males, and the observations of Dr. Bucke, of the Asylum at London, Canada, would seem to verify such a belief. In a recent report, in referring to the restraint required in an average population of 372 men and 304 women, he says that 25 men were restrained and secluded 4,079 hours, and 68 women 20,324 hours. The reporter offers no explanation for this, but states that, on the whole, females are more unmanageable than males.

Women are said to enjoy considerable immunity from the general paralysis of the insane, and consequently to escape the frequent paroxysms of excitement which characterize this phase of mental disease. On the other hand, women are subject to a monthly aggravation of

[1] Op. cit.

[2] Othæmatoma, or the Insane Ear. West Riding Lunatic Asylum Reports, Vol. v., p. 140, 1875.

[3] Hæmatoma Auris. A. J. I., July, 1870. Reprint.

symptoms during the menstrual period, since the mentally sane even are more irascible and nervous at this time.

The treatment of female lunatics, moreover, is more gentle than that of males, since their attendants are usually of their own sex, and less liable than male nurses to injure the ear in handling violent and idiotic patients. The ears of a female are somewhat protected by their hair and head-dressings.

3. *Cachexia.*—A dyscrasia commonly attends cerebral disturbances in both insane and intemperate persons, and although othæmatoma by no means always appears in subjects when the bodily health is most impaired, yet must we not entirely ignore a perversion of general nutrition, since this state may be in some degree predisposing. The scorbutic or rheumic diathesis, or chronic alcoholism may thus tend to impair the texture of the coats, when laceration of the blood-vessels of the cartilage and perichondrium would more readily take place in passive hemorrhages occurring under undue excitement. Thus Dr. Wallis,[1] superintending physician of the Insane Asylum at New Ruppen, assumes a cachectic condition in conjunction with trauma as composing the etiological factors in othæmatoma.

Causative (*traumatic*) *agencies.*—In the mentally sane the affection is most commonly met with among prize-fighters, gymnasts, persons given to violent sports, and among drunken and disorderly persons, where blows and falls are frequent.

As regards the insane there has existed much diversity among writers as to the cause. M. Bouteille, who does not absolutely reject the influence of predisposing causes, believes that othæmatoma never appears without violence to the auricle, and, in alluding to an epidemic of othæmatoma which occurred at Lyons in 1879, states that the trouble disappeared by simply changing attendants.[2] But it is believed that the ear is now less frequently injured by violence than formerly, since mechanical restraints are less in vogue, and an amelioration in the general management of the insane has gradually taken place. Not long ago it was not unusual for attendants to lead resisting patients by the ear, and otherwise maltreat the organ.

In some of the institutions for the insane where the writer has made inquiries concerning the prevalence of othæmatoma, it would seem to be of infrequent occurrence; in one asylum a case had not been observed in "three or four years," and in respect to this matter

[1] Med. Zeitung, herausgegeben von dem Verein für Heilkunde in Preussen, 1844. No. 32, p. 147. Ibid., 1845, No. 45, p. 211.

[2] Annales Médico-Psychologiques, Juillet, 1878. Abst. A. J. O., vol. i., p. 69.

in another institution the superintendent writes that the case books show that the "phenomenon has been regarded as a curious incident worthy of mention, but without sufficient importance in the history of the insane individual to merit description."

From a careful study of the subject the author has come to believe that othæmatoma is almost always due to violence inflicted upon the auricle. Asylum superintendents, however, have been on the whole, perhaps, rather disposed to undervalue the importance of mechanical causes, since it might be constructed to imply undue restraint or rudeness in the management of their patients.

It is true that the trouble does not always supervene during paroxysms of violence, but it is difficult or impossible even to trace physical injury in all cases, or to show *per contra* that the violent patients have not injured themselves. Lunatics themselves injure their ears by self-inflicted blows. The extent to which this is carried by these unfortunate people, whose ears are, as a matter of fact, much less sensitive than normal, is much greater than would seem possible to any one unfamiliar with their habits. It is not uncommon for any one to strike with the fist upon a region of the body where a morbid process gives rise to slight pain, and even sane persons pull and rub the auricle violently under certain conditions. The insane carry this much farther, especially when under excitement. One should not lose sight of the fact that the insane are liable to experience much discomfort in the ears from diseases of the organ, to many of which they are particularly subject, but delusions and hallucinations are frequently so associated with tinnitus aurium and autophonia that the patient's attention is continually drawn to the ear. They have delusions respecting the presence of persons and things in the head, and concerning fancied attempts of "evil spirits" to gain admission thereto; they are in constant dread when awake, because of the abusive and threatening language which they imagine to be spoken into the ears. Frequently the patient's words become autophonous when the ears and head seem "empty" or "cavernous"; it then becomes yet more difficult for the patient to not imagine or believe that abominable and dangerous occupants have taken possession of the disordered and void dormitory of the mind. Autophonia, which is an expression intended here to embrace the various forms of tinnitus as well as autophonous vocal and respiratory sounds, gives rise to hallucinations in mentally sane subjects even, especially in the aged and feeble.

Worthy of mention in this connection is the distressing itching and burning sometimes set up in the ear in neurotic subjects, relief

from which is sought by constantly pulling, pounding, rubbing, and pinching the external parts. The writer has known sane persons to endeavor to get some relief from the torture of pruritus of the ear by treating the organ with much violence; a lady under his care at the one time often found herself involuntarily scratching the auricle and temple on account of "creeping sensations" in the ear, and another patient, a clergyman, had the habit of thrusting a large pin deep down into the external auditory canal to scratch the parts; he also rubbed the auricle at times until it became intensely injected.

Lunatics often thrust objects like wool, rags, etc., into the external auditory canal to get rid of disagreeable noises in the ears and head. The organ is frequently injured in this way; the author has, for example, seen a case where much damage was inflicted by thrusting the rough end of a china doll's leg into the ear, and in another instance, a large abscess was produced on the inner surface of the auricle by rubbing and contusing it with a stone. In some instances, the insane strike the head against some object with great violence, the injuries thus produced leaving the auricles abraded and scratched; others thrust their forefingers into the ears and furiously shake and pull the organs—in one case seen a papillary growth had developed at the entrance of the external auditory canal on one side in consequence, and both auricles were greatly enlarged.

It will thus be seen that insane persons very frequently have a fancy that the organ of hearing constitutes the portal of the mind, and we need not wonder, therefore, that it is so frequently assailed.

Among other numerous causes may also be enumerated the violent movements of certain insane persons when in bed; their pillows, frequently consisting of materials no softer than straw or husks, are liable to injure their ears, especially during their struggles under restraint. Again, when forcibly fed, while the head is held in the strong embrace of the nurse, the ears are liable to injury. Insane paralytics, if allowed to remain too long without change in position, may suffer from an interference in the process of nutrition on account of the undue pressure upon the ear. Sloughing of the auricle from long-continued pressure in lying upon the organ in cases of fever not unfrequently occurs in the mentally sane.[1]

Othæmatoma has been described by writers on the ear as due to bites, burns, dentition, etc. Urbantschitsch[2] reports the case of a

[1] Williams' Treatise on the Ear, p. 108. London, 1840.
[2] Lehrbuch, p. 89.

woman where both ears were believed to be thus affected by a bite of some kind, and Kipp[1] reports the case of a child, considered to be thus affected, where both auricles were injured by a burn. Cases supposed to be due to dentition are related by Frank,[2] who says: "During dentition, this condition is often observed to occur, usually in scrofulous subjects." The writer, whose experience in this disease has been considerable, has never seen othæmatoma arise from any of these causes, and it seems probable that in some of them at least phlegmonous inflammation only may have been present.

In reviewing the causes of othæmatoma, it would seem that it has no special preference for either sex or for any one form of insanity, and that it may be produced in the mentally sane by contusion of the auricle. That it depends almost exclusively upon traumatic influences in all cases seems a warrantable deduction.

From the examination in his own practice of a very considerable number of cases of othæmatoma occurring in both mentally sane and insane subjects, and consisting of cases in progress as well as where recovery had taken place, the writer entertains no doubt in his own mind as to the *universal and immediate precedence of trauma in every instance.*

Occurrence.—The more frequent occurrence of othæmatoma in the left ear has been the subject of much speculation. Stiff[3] drew attention to this preference; he found that in 17 cases the left ear was affected in 6 cases, the right ear in 4, and both ears in 7. Of the 24 cases reported by Lennox Browne, the left ear was affected in 19, the right ear in 2, and both ears in 11; when both ears were affected the left was first attacked. The experience of some observers has been the reverse of the authorities above quoted; thus Hun,[4] in his 24 cases found the right ear to be the seat of the trouble in 9 cases, the left in 5, both ears in 9, and in one the history was incomplete in this regard. In the cases where both ears were affected it is not stated which side was first attacked.

The greater frequency of occurrence in the left ear does not seem to hold good in the mentally sane (see table of the author's cases, p. 151), with the exception of pugilists, who more frequently contuse the left auricle.

[1] Trans. A. O. Soc., 1867, p. 79.
[2] Ohrenkrankheiten, p. 248.
[3] Loc. cit.
[4] Loc. cit.

Various theories have been advanced in explanation of this peculiar manifestation. Thus it has been suggested that the near position of the left carotid artery to the heart affords a more direct blood supply to the left ear, and that, furthermore, the left pinna is oftenest affected, because pulling or striking the organ is more liable to be done with the right hand, the left ear receiving the injury. The left ear, it is said, is also more liable to injury than the right in forcible feeding, since in holding the patient the arm of the nurse usually presses it with more or less violence against the head.[1]

An explanation of the greater frequency of left-sided othæmatoma, however, must be sought in some other direction, since the above apply mainly to mechanical agencies only. It seems probable that some very intransient influence must exist to cause the trouble to appear so frequently on the left side, and could this be discovered, much light would doubtlessly be thrown not only on the etiology of othæmatoma, but also on other aural diseases. It has occurred to the writer that probably some vaso-motor influence might be found to lie at the bottom of the difficulty. It is a fact that unilateral sweating about the head is not an uncommon occurrence; and, moreover, in bilateral chronic catarrh the left ear is seemingly much more rapidly invaded than the right in a notable number of instances —a condition due, in all probability, to some vaso-motor disturbance whereby the nutritive process is interfered with much more on the left than on the right side. While this agency may be found to lie in some cerebral or cerebro-spinal condition, there exists a prominent irregularity in the distribution of the sympathetic nerves which it occurs to the writer might bring about such a result. Reference is had to the peculiar arrangement of the nerves extending upward from the cardiac plexus to the two sides of the head. According to anatomists there is to be found here an important irregularity. Thus, while an unvarying connection is maintained with the right side through the superior cervical ganglion, a comparatively imperfect and varying connection exists on the *left* side—the left superior cardiac nerve and the inferior cardiac branch of the pneumogastric only occasionally affording communication between the cardiac plexus and the left superior cervical ganglion.

Of course, other but less direct communications exist, which bring the cardiac plexus into relationship with the left ear, nevertheless the asymmetrical distribution above described might be the means of

[1] The writer's attention was drawn to this latter explanation by Dr. Craig, Assistant Surgeon, New York Asylum for the Insane.

diminishing the vaso-motor dominance, in respect to the circulation in the left ear. Granting the correctness of the hypothesis, which, however, is by no means held to be indisputable, the disparity in the vascularity of the two ears would finally produce distinguishing nutritive changes in the tissues of the parts—alterations especially well marked in the tympanic membranes in *otitis media catarrhalis chronica*, where the membrane of the *left* tympanum will frequently be found to be quite parchment-like and lustreless, while the right membrane is yet in a fairly normal condition. It is thus difficult to see why nutritive changes may not affect the cartilage of the left ear more frequently than the right, and give rise to the greater frequency of othæmatoma on the left side.

Othæmatoma is frequently bilateral, very often developing equally on both sides. It may develop rapidly and disappear again as rapidly as it came. This bilateral invasion is suggestive of central nervous origin.

Pathology.—After what has been previously stated in respect to this affection, there remains but little to be said concerning its pathology. There seems to be but little doubt of the existence in many lunatics and inebriates of incipient softening and disintegration in the tissues of the auricle, which predispose to separation of the perichondrium from the cartilage; that this is always a factor of very great importance in the production of othæmatoma may well be doubted, since the disease is scarcely ever known to occur in advanced life, when such changes would be greatest, unless mechanical agencies intervene. The extent to which softening of the cartilage may proceed without any symptoms manifesting themselves is not, of course, known, but from the following extract it is probably very considerable. Referring to the pathological histology of the cartilaginous framework of the ear,[1] Pollak shows that specimens "which were taken from the ears of individuals who had not, so far as he could learn, been affected with any form of mental disease," had "in the cartilaginous portion of the external meatus, and especially in the antihelix, small nodules" varying in size "from a mustard-seed to a lentil." These, when cut open, showed to the naked eye even a departure from the normal condition of the reticulated cartilage, and sections under the microscope were found to be deprived of the fibrillated network in places, and instead there was a structureless mass. In some places the breaking-down process was even more marked.

[1] Monatschrift für Ohrenheilkunde, July, 1879—Rev. in A. J. O., vol. i., pp. 302, 303.

Where an actual cavity was made out, it "lay wholly within the mass of cartilage, and at no point was bounded by the perichondrium, which everywhere appeared to be perfectly healthy."

These tumors are formed of serum, or serum and blood, which is effused, not under the skin, but under the perichondrium detached from the cartilage; the contents are not ordinarily completely liquid, but are liable to contain fibrous or gelatiniform clots, which if not evacuated attach themselves to the internal surface of the sac during the process of union between the two surfaces. It was formerly believed that the exudation produced a new formation of cartilage, sometimes constituting a uniform layer, sometimes small patches only, which was the cause of the thickening of the ears. Virchow,[1] however, alleges, that the cartilage so commonly found in these cases consists of detached portions of greater or less size, which remain adherent to the perichondrium, and are not of new formation.

A peculiar variety of othæmatoma ought to be mentioned which is not always easily distinguishable from hyperæmia, a condition, in the writer's experience, only met with in the insane, where it is probably due to protracted and violent rubbing of the auricle. Any portion of the perichondrium may be involved, but it is usually limited to a small space. Thickening is often scarcely observable, and to the feel it is not "doughy." The deep-seated nature of the inflamed or congested region, however, may be discovered by stretching out the auricle between the observer's eye and a strong light. The effusion is not sufficient to form a tumor; such cases seem to present the characteristics of the first stage of othæmatoma. Case V. is an example of this condition.

These sanguineous cysts, as they are sometimes called, may be limited to a slight extravasation scarcely distinguishable from deep congestion, or they may consist in a tumor of greater or less dimensions. The tumor, although not always consecutive to an inflammatory process (as in immediate extravasation from traumatic laceration), is, however, usually characterized by more or less inflammation of the cartilage and perichondrium of the ear, and by the sudden escape of sanguineous fluid between the cartilage and perichondrium, and, it is said, into the substance of the cartilage itself. The size of the tumor varies from that of a Lima bean to an egg; its formation is usually rapid, and the contents, at first fluid, show a marked tendency to become clotted, and quite often, unless incised, spontaneous rupture takes place.

[1] Pathologie des Tumeurs, vol. ii. Paris, 1867.

In the milder attacks, extravasation is so slight that it has been characterized as a serous œdema.

Generally the outlines of the outer surface of the pinna, formed by the foldings of the cartilage, are more or less obliterated, according to the extent of the tumor; where there were ridges and depressions before, the surface will be smooth, and usually convex even.

The exudation always takes place, as far as the writer's own experience goes, on the outer surface of the pinna, and seldom affects the inner surface at any period of the disease. The swelling in most cases begins near the superior border of the pinna, but it may show itself on any portion of the exterior surface, including the concha. *The lobule is never directly affected*, since it contains no cartilage, and the cartilaginous portion of the external auditory canal is seldom involved. The tragus seems to enjoy entire immunity from attacks.

This selection of the outer surface of the auricle seems to be owing to the greater vascularity of this region, upon which the branches of the anterior and posterior auricular arteries ramify and anastomose, and to the fact that it almost invariably receives the impact, when the auricle is struck, with greatest force. Where there is an inflammatory movement in the parts, the connective tissue on the inner surface of the pinna may become the seat of suppurative action, and an absces may form; or, should perforation of the cartilage take place, the contents of the tumor may pass through from the anterior cyst, separating the perichondrium from the cartilage on the inner surface, and escape into the connective tissue even.

Symptoms and Course.—Subjective symptoms are usually present where occlusion of the external auditory meatus is produced by swelling of the concha; they consist in deafness—due to closure of the canal—and tinnitus aurium—from increased tension of the membrana tympani. The extent of these symptoms in lunatics cannot with accuracy be determined.

In the beginning of an attack, and during its progress, the patient sometimes experiences a feeling of heat in the affected organ, like the extreme congestion due to flushing; in the insane, however, precursory signs are not likely to be reported.

When the invasion takes place, the affected region usually presents a hyperæmic appearance; frequently there is in lunatics a very decided flow of blood toward the head, producing great capillary turgescence of the face, ears, and eyes; in some instances an effusion of blood beneath the conjunctiva of the eye has been known to occur simultaneously with the appearance of the othæmatoma. In the more severe cases, where the characteristic effusion takes place rapidly with

inflammatory action, there is often an elevation of temperature; and in nearly all instances the integument assumes a bluish or purplish hue. The affected organ is seldom very painful, even where the tumor is greatly distended or roughly handled, especially in boxers and lunatics, where the parts have been subject to rough treatment from repeated contusions; in the latter, however, the ears are wanting in sensibility at all times. The writer has, however, frequently observed that sensibility is very much exalted in some cases occurring in sane persons.

Othæmatoma occurring in pugilists differs in no respect from that found in lunatics, its progress being influenced by the general condition and habits of the patient in both instances.

The retro-active consequences of this local trouble in the insane need not be considered here, yet it is worthy of note that the posterior auricular artery, through one of its branches, the stylo-mastoid, communicates with the middle meningeal by anastomosis, thus establishing a significant and important relationship between the ear and the meninges of the brain. In the mentally sane this becomes a factor of serious import, and should not be overlooked; besides, more or less general nervous sympathy may exist in sane patients.

Parts contiguous to the ear are sometimes implicated in an extension of the inflammatory process; neuralgia may be kindled into action, and general febrile action may supervene. Whilst othæmatoma may be produced by disease or wounding of the cartilage of the external auditory canal, it seldom extends itself to these parts from the pinna; and the middle ear, so far as is known to the writer at least, has never been invaded by an extensive inroad of the inflammatory process.

The *progress* of the tumor varies very much; it may rise to a considerable size in the course of a few hours, and when first seen may be as large as an almond or a walnut. Sometimes the distention continues to progress rapidly, the walls becoming thinner in consequence of the stretching, until, finally, in the worst cases, they undergo spontaneous rupture unless relieved by an operation. In asylum cases it is not unusual to allow the cyst to burst in this manner; thus of the twenty-four cases reported by Hun, fifteen ruptured spontaneously; in one of them the left ear burst on the twelfth day at the upper part of the concha, while the patient was sitting in a chair, and the contents "were thrown to the ceiling, a distance of twelve feet, so as to stain the plaster."

These tumors are, however, frequently without some of the symp-

toms of inflammatory action, passing through all of the stages of the disease without either heat or pain being experienced by the patient. This variety manifests a disposition to develop slowly, and has a tendency to spread itself laterally rather than in thickness, as in Case I.

The contents of the tumor, even when at first serous, usually become sero-sanguinolent sooner or later. In some instances, however, the serous character continues throughout. In most cases an early formation of coagula takes place in the tumor, which, not being reabsorbed, increases ensuing deformity. In the milder form of the affection, sometimes described as "œdematous," but little fibrous tissue remains, re-absorption being more complete ; such cases seem to pass through all of the stages with but moderate inflammatory action.

The wound which affords an outlet for the contents of these cysts, when they require any, whether from puncture or due to spontaneous rupture, has no tendency to remain open, and the cavity, therefore, sometimes refills in the course of a few hours ; on the other hand, in certain cases the cyst pours out fluid so rapidly that a discharge constantly trickles down from the opening, thus preventing the wound from closing.

The *duration of othæmatoma* will of course vary greatly, depending as it does on the severity of the case, the rapidity of reabsorption, and the habits of the patient ; thus in lunatics, inebriates, and boxers the organ is liable to repeated contusions, giving rise to aggravations which may retard the cure. Sometimes reabsorption comes to a stand-still, and a considerable tumor remains for an indefinite period of time. Case II. is one of this kind which was seen by the writer.

Termination.—In a very considerable number of cases the disease will terminate spontaneously in from four to eight weeks, depending somewhat on the extent of perichondrium affected and the quantity of the effusion ; othæmatoma, however, cannot be said to have any regular course where it occurs in irresponsible or uncontrollable patients. It will be found that among any considerable collection of lunatics or prize-fighters, no very small number have their ears more or less deformed by previous attacks of othæmatoma. In some lunatics, where well-marked deformity presents itself in one auricle, the other will be found so slightly deranged as to be liable to escape detection altogether unless closely scrutinized, and in others scarcely any observable thickening will be found in the affected organ, the deeper coloring alone affording evidence to the eye, whilst the slight

induration, thickening, and immobility of the skin are not to be detected without careful handling.

It seems exceedingly probable that, in certain cases where the alienist is in doubt as to the sanity of a patient, valuable confirmatory evidence of previous mental trouble might be obtained by an examination of the ears. Where the deformity is great, in consequence of an extensive area of cartilage having been exposed by detachment of its perichondrium, the skin on the outer surface will usually be found to be immovable, whilst that on the inner surface remains unchanged. In these cases the concha is liable to be much reduced in dimensions, its posterior wall being often so much thickened that a narrow vertical slit only remains in front of the meatus externus, preventing the introduction of any but a speculum of the smallest size. It is scarcely necessary to add that the deformity arising from othæmatoma is not influenced by the mental condition of the patient.

The characteristic deformity resulting from othæmatoma is well shown in Cases VI., VII., VIII., IX., X.

In its regressive course, the contents of the tumor are gradually reabsorbed or a puncture gives them exit, the surfaces gradually come in contact, and the outlines of the cartilage begin to reappear, but more or less altered in distinctness. If obliteration of the cavity is accomplished by a moderate exudation of lymph uniting its walls, the deformity will be slight, especially if the tumor has been but moderately distended by fluid. On the other hand, where the perichondrium has been greatly stretched by extreme distention of the sac, it contracts upon itself as reabsorption takes place, and adaptation to the cartilage as before cannot occur; the misshappen appearance of the cartilage increases with the continued contraction during the process of adhesion. The ear finally becomes indurated, and the skin on its outer surface is immovable, and follows the outlines of the distorted cartilage underneath. Sometimes the organized lymph which obliterates the cavity enormously increases the thickness of the auricle, an example of which condition is shown in Fig. 24. Where a thin plastic layer only intervenes finally, as occurred in Case XIV., the auricle is likely to be reduced in size, and becomes comparatively thin and shrivelled; in either case permanent and characteristic deformity results.

In some cases, where the effusion has been slight or imperceptible even, the plastic exudation does not form a layer of any great magnitude, and but little thickening is left behind; the mobility of the skin is less affected, and consequently the ensuing deformity is scarcely recognizable.

It should be mentioned, in concluding these remarks on the progress and termination of the disease, that in some cases which the writer examined among insane persons the othæmatoma was observed at first to make but slow progess, remaining stationary even for several weeks, when, without any apparent cause or active inflammatory symptoms, it would gradually increase in size. It is extremely probable that this was caused by some new trauma to the auricle.

Diagnosis.—The "Asylum Ear" was, by all observers half a century ago, regarded as a curiosity simply, and even at the present time it seems very often to escape attention entirely, or to be merely entered in asylum case-books as a nondescript phenomenon. It is to be hoped that a want of knowledge in this respect will not long prevail where the disease is liable to occur, and where treatment may do much to ameliorate the condition of the patient. In fact, the want of adequate knowledge in regard to othæmatoma seems scarcely any longer excusable when we consider the light that has been thrown upon the subject during the past twenty years by various authors.

In distinguishing this affection from erysipelas, phlegmonous inflammation, frost-bite, burns, eczema, tubercular syphilis, and other cutaneous affections, one almost constant causative agency should be first sought for, namely, trauma. Whether predisposing conditions are present or not, the history will give unmistakable evidences of this factor. There may often be reasons for suppressing the truth; persons may desire to conceal the fact of blows having been administered, or they may have been so slight as to have escaped attention, nevertheless where othæmatoma is suspected, inquiries in this direction should be diligently pressed.

The essential nature of the affection depending on a perichondritis of the cartilage of the auricle, its existence may be readily detected by examining the contents of the tumor, which will be found to be serous or sero-sanguinolent. These tumors are usually of rapid formation, and speedily refill again on being evacuated. It will be found that they have well-defined and resisting walls, a fact which may be determined by exploring the walls of the tumor with a probe after it has been incised or ruptured.

Abscesses or blood extravasations rarely develop in the scanty connective tissue of the auricle, and they are much more limited in dimensions than othæmatoma; their walls, moreover, give way to moderate distention, and their progress will be found to be less protracted than the tumors under consideration.

Suppurative perichondritis has been alluded to by writers, but pus is seldom found in these cysts; extravasated blood may, however,

become putrescent, or a perforation of the walls of the cyst may afford a communication with an abscess behind the cartilage of the auricle, or with the deeper parts about its attachment to the temporal bone.

Abscesses, however, may develop in the post-auricular connective tissue during the progress of cases of marked inflammatory tendency or as a result of contusions. In such cases, or where swelling occurs without maturation, an asymmetrical prominence of the auricle occurs. Case IV. is one in point.

In many cases of othæmatoma the auricle does not stand off from the head, the disease being limited to the wing of the ear throughout. Parts contiguous to the auricle are always the last to be affected, if invaded at all. The trouble may be distinguished from erysipelas, for which it was formerly sometimes taken, by its well-defined sacculated appearance and the absence of superficial changes common in erysipelas. Eczema and erysipelas, unlike othæmatoma, are liable to extend into the external auditory canal, while the latter, at most, usually, occludes the meatus by the encroachment of its sac. The cutaneous affections mentioned above, moreover, frequently invade the neighboring parts, especially the inner surface of the auricle; none of them, however, leave the deformity which characterizes othæmatoma. Nævi may resemble othæmatoma very closely in some instances. The writer once saw a case of this kind occurring in a woman where a large portion of the auricle was involved. The marked pulsation and absence of fluctuation in such a case would serve to distinguish it from othæmatoma. The age of the patient should be considered in arriving at a diagnosis; thus eczema, for example, is most frequent in infancy and childhood, whilst othæmatoma is more particularly a disease of adult life.

Prognosis.—This affection probably has no prognostic value in respect to the occurrence, course, or duration of insanity. The trouble cannot be said to augur against recovery, since it occurs in dementia when bodily health is improving, nor is it obnoxious to any particular form of insanity. In Hun's reported cases, nine of the patients died insane in the asylum, nine were discharged unimproved, and six remained when the report was made—one of them in a state of dementia.

Generally the disease runs the course already described, without any complication that endangers life, although, when extravasated blood becomes putrescent, there may be danger of septic poisoning.

Hearing undoubtedly suffers considerable impairment in some cases through the deformity of the outstanding cartilaginous framework of

the ear. In the case of a pugilist examined by the writer, whose auricle was greatly disfigured, there were permanent defects in this regard, apparently due to the interference with the normal tension of the membrana tympani—*vide* Case XX.

Recurrence of the tumor is, of course, impossible, where complete obliteration of the secreting surfaces has occurred, although repeated contusions in an auricle previously affected may give rise to more or less inflammation of the organ. In several prize-fighters examined, where ears had been previously the seat of othæmatoma, constant bruising of the organ seemed to occasion very little local disturbance.

Treatment.—The treatment of contusions of the ears, of course, attracted the attention of ancient physicians. Thus Paulus of Ægina, in treating of these injuries, did not think any treatment required; since it was necessary, however, to do something, he recommended that a local application of myrrh, aloes, etc., be employed. Hippocrates found that some of these injuries were much more grave in their nature than others, and he seems not to have found their treatment satisfactory. He shows a want of faith in bandages or cataplasms, as he believed that they favored the formation of abscesses and established suppuration; the ear, indeed, seemed to stand in need of such applications less than any other part, and none were sometimes good treatment. When suppuration (effusion?) threatened, there need be no haste in making an incision, for *often the matter* (?) *was absorbed again* [italics the writer's]. Were he forced to open it (the tumor?) he preferred transfixion with a cautery, since by means of this method the parts get well soonest, and yet it should be well understood that deformity will ensue and the ear be smaller than the other if thus burnt through. If an incision were decided on it should be freely made on the upper (outer?) side, for, he says, the pus (?) is found to be surrounded with a thicker covering than one would have supposed. After incisions, which may not always be followed by evacuation of mucus (serum?), cataplasms and pledgets are to be avoided. The true nature of othæmatoma was unknown in the time of Hippocrates, and in the treatment of the affection he was probably not aware that a separation of the perichondrium from the cartilage takes place, and that the detached surfaces supply the serum, which he wrongly believed to consist of mucus.

In the treatment of othæmatoma in insane and intemperate persons, among whom it mostly occurs, besides the difficulties encountered in controlling the actions of the patient, mental disease and intemperate habits exert an unfavorable influence, and thus delay recovery. Insane persons are more obnoxious to the trouble when under great excite-

ment, as in acute dementia; and their violent and restless movements interfere very much with treatment, whilst pugilists are indifferent, and generally neglect any advice given them. It is a safe rule in the beginning to be in no haste to interfere unless rupture of the sac be imminent, since in a certain number of cases a manifest tendency to spontaneous recovery exists.

In laying out any plan of treatment in this disease, it will be well to remember that whatever the supposed cause or causes may be, we have to deal with a perichondritis, in the treatment of which we should be guided rather by its character than by its causes. And furthermore, one should be on their guard in respect to the strong tendency to interfere in these cases; this is well expressed in a paper on the subject by Wallis.[1] This author treated these tumors as abscesses, and after incision they were poulticed and treated with stimulating lotions, "but almost always with unfavorable results—gangrene, and carious destruction of the cartilage, and not rarely death, was the end." This experience induced Wallis to fall back on nutritious diet, mild cathartics, and the local application of lead wash—in all other respects treating the swelling as a *noli me tangere*. This treatment, continued for weeks, was successful in a number of cases. Fischer came to the conclusion that eight weeks' treatment affects neither the termination nor the duration of the disease, an opinion coinciding closely with the one held by Marcé, whose belief was that othæmatoma is not influenced by any treatment, but usually remains for about four months. In regard to the views above cited, however, it should be said that the fatal results alluded to by Wallis are quite exceptional, similar experiences being unknown to other writers, while Fischer and Marcé seem to have carried the expectant plan too far, since no treatment is *not* good practice in all cases.

In its aggressive stage the observer is seldom offered an opportunity to take cognizance of the incipient symptoms. Usually a tumor is already found to exist, and the first consideration will then be to limit its extension, if possible. If it is found that the quantity of the serous or sero-sanguinolent exudation is not great, we may prescribe rest for the patient, and administer small doses of the tincture of aconite root with a view to arrest the activity of the circulation of blood about the head. Locally the affected region, and beyond even, may be enveloped with a coating of collodion, the gentle and uniform pressure produced by its contraction acting as a compress, and thus promoting absorption.

[1] Loc. cit.

Case XI. is a good illustration of the treatment and progress in a case of this kind.

Reabsorption is sometimes retarded by the general condition of the patient, and it is alleged by some authors that a comparatively scanty distribution of lymphatics characterizes this region. Whenever this tendency manifests itself, it will be well to employ measures likely to hasten reabsorption. We may act on the presumption here that the inflammatory reaction frequently attending the regressive stage is wanting or inefficient, and proceed to employ massage or pressure. In the writer's own experience, the latter has been generally unsatisfactory.

The massage treatment consists in pressing and rolling the affected portion of the pinna between the thumb and forefinger for some minutes or more at a time. This manipulation is usually unattended by pain, and, moreover, has this advantage, that it can, when necessary, be entrusted to sane patients themselves. At first it may be practised once or twice daily, and afterward more frequently, the length of each séance being extended as treatment progresses.

The behavior of these tumors under continued and even severe bruisings is instructive. The writer's observations of othæmatomata in pugilists demonstrated the fact that recovery is not impossible under apparently unfavorable conditions, although it should be added that unsightly deformity remained.

In resorting to methods calculated to increase absorption, however, care must be exercised lest they increase unduly the local irritation. In relation to this matter, the following paragraph is suggestive: "Physiologically the membrane of serous cavities secretes a serous fluid, which is taken up again by the vessels with great facility; this faculty of reabsorption is demonstrated by the rapid disappearance of injected fluids. But if the serous membrane is inflamed, the reabsorption of an injected fluid is impossible (Rindfleisch), and the irritation of the serous membrane determines an abundant secretion. Even a slight irritation is sufficient to transform a serous bursa into a cystic cavity. Such a transformation of a subcutaneous serous bursa is known as a *hygroma*, and may be called a tumor because of its tendency to persist indefinitely."[1] If extravasation in the beginning goes on rapidly, threatening to denude the cartilage more and more, or where reabsorption comes to a standstill, an aspirating needle may be inserted into its most dependent part and the fluid evacuated; the subsequent treatment should then consist in the methods already

[1] Cornil and Ranvier: Pathological Histology, pp. 167, 168. Philadelphia, 1880.

recommended. The evacuation of fluid may be repeated as often as the sac refills. The operation can usually be performed with the ordinary hypodermic syringe.

When the tumor is large and contains a considerable clot, it is best to make an incision large enough to permit the contents, including the clot, to escape; and, since the tumor is almost sure to refill again, a silk seton may be passed through the opening thus made and brought out again, above, to insure drainage. The wounds, having a strong tendency to reunite, should be kept open by occasionally drawing the seton through the tumor whilst pressing out the contents. As soon as the secretion lessens, its removal will be best accomplished by aspiration. It was formerly recommended to bring about adhesive inflammation by keeping up irritation with the seton, but this can be much better accomplished by massage.

When the above treatment is judiciously employed we may expect to witness a gradual diminution of the tumor and complete reabsorption of the fluid in three or four weeks; and, moreover, it is believed that much less disfigurement will ensue than occurs in cases allowed to run their course without such aid. The longer an actively progressing tumor is permitted to go on toward spontaneous rupture, the greater will be the separation of the perichondrium from the cartilage, and consequently the greater the ensuing deformity.

Sometimes it happens that the regressive stage runs on into a chronic condition, and the walls of the cyst fail to unite, or else a permanent sinus remains. Under these circumstances, it will be necessary to *destroy the secreting surface of the cyst.* This may be accomplished either by the application of escharotics or irritants to the walls of the cyst. In regard to the selection of an irritant for this purpose, none has been found equal to a strong solution of iodine in the author's experience. A free incision into the tumor should be made, the cavity cleaned out, and its surface freely painted with Churchill's solution of iodine.

The walls of the tumor are afterward to be kept in contact by pressure. The injection of small quantities of the tincture of iodine into these tumors has proved to be temporizing and unsuccessful. Case II. is an example of the advantages of the method recommended above. When the operation already described fails, or for any reason seems inadvisable, the surface of the walls of the tumor may be abraded throughout with the fenestrated cutting scraper, as in Case III. Where any projecting edges or sharp folds of the cartilage prevent the walls coming together, they may, where the correcting of deformity is desired, be extirpated by dissection.

After the operation, the walls should be kept in contact by bandaging (pressure). In the writer's experience, otoplastic operations can be performed with considerable freedom in these cases without fear of undue reactive inflammation, the wounds healing readily in the insane, even where low recuperative action might be expected to exist.

The cases which are given below, occurring both in the mentally sane and in the insane, while showing that the affection is obnoxious to both classes, teach us at the same time that the trouble in the latter is subject to influences which usually render its management more difficult than in the former. In the treatment of othæmatoma in the insane, it would be well to keep in mind that, subsequently to the period of greatest local congestion, there is very often, probably, a *decrease* in the temperature of the auricle, which may be due to more or less complete restoration of vaso-motor dominance, a condition scarcely distinguishable to the eye from active turgescence, although to the touch the parts are cold even. The writer had no opportunity to test this matter by thermometrical observations, and is, therefore, unable to state the exact degree of depression which probably exists.

One should not be in haste to interfere in these cases; in general it may be said that the dictum of Hippocrates, namely, that the employment of cataplasms and pledgets are to be avoided, is as safe a guide now as it was in his own day. But while excessive poulticing is to be avoided, there are probably some few cases where hot fomentations or light emollients of various kinds may, when judiciously applied, prove grateful in an auricle highly inflamed. As regards pledgets, however, their employment is always liable to do harm, since they give rise to undue irritation if employed early, and the distention produced by them later on, when thrust into the cyst, prevents the walls of the tumor coming together and adhering to each other. The employment of ointment has not, seemingly, been a favorite mode of treatment, but belladonna ointment would no doubt be beneficial where the cutaneous circulation is languid. In the regressive stage, dilute tincture of arnica is of service, as in other contusions.

Where suppurative processes arise, as they sometimes do, in the inner portion of the auricle, the post-aural region, or contiguous to the cartilaginous canal, the calcium sulphide (Calx Sulphurata of the Pharmacopœia) is indicated.

That these patients should be kept quiet, and usually in a restful attitude, need not be dwelt on here. The self-infliction of further

injury, or its production by others, among insane persons, should be prevented. Attention to general health, of course, must not be overlooked.

In conclusion, the introduction of a few cases, illustrating the more important points which it has been endeavored to bring out in the foregoing remarks, may be found of interest.

CASE I.—W. W——, an Englishman, 43 years of age, by occupation a negro minstrel; health good, and he claims to have no bad habits; never had any aural disease before; came to the New



FIG. 20.

York Eye and Ear Infirmary May 4th, 1880, and stated that two weeks ago, while washing the burnt cork from his face, he had felt a slight soreness on the top of the right auricle. On examination, he found a small tumor on the outer aspect of the auricle, which afterward gradually increased in size until it obliterated the antihelix, and finally became about one-half an inch in thickness. On shaking his head, the patient could "feel the contents of the tumor rattle."

The physician under whose care the patient first came had painted

the tumor with the tincture of iodine for the first few days, and it had decreased somewhat in size. When the iodine stains disappeared, the color of the tumor was found to be but little more red than normal. but its walls were thickened. Under the expectant plan, the fluid continued to be reabsorbed quite rapidly, and later on the contents had a doughy feel. During the next four weeks, the patient occasionally painted the ear with tincture of iodine, and it diminished notably in size. Thickening and immobility of the integument, however, remained. There was no shrivelling of the cartilage, and but little deformity from the remaining induration of the parts. It is the belief of the patient that the auricle, previous to the beginning of the swelling, had been struck a slight blow by a papier-maché stove, which he had to throw upon his shoulder during a play.

Fig. 20 represents the appearance of the ear immediately after the tumor had commenced to subside.

In six weeks from the first appearance of the tumor, there remained but a very slight thickening of the tissues. No fluid was present and no deformity of the auricle. It will be interesting here to state that this same patient came to the author recently (April 27th, 1887) for treatment, with an othæmatoma of the left ear. Patient had noticed the swelling two weeks before and attributed its presence to the rather hard rubbing of the auricle, necessary for removing the burnt cork. Treatment consisted at first in drawing off the fluid contents with a hypodermic syringe. This was done three times. bloody serum being drawn off on each occasion. The tumor was also painted with collodion at first, and a week later massage employed. The drawing off of the fluid contained in the tumor did not apparently result in any permanent reduction of its size, as this quickly collected again. Four weeks after the patient was first seen, there remained a slight thickening of the tissues. the fluid being nearly absorbed. Massage was continually employed together with the application of mercurial ointment. The result was very satisfactory.

CASE II.—Charlotte K——, aged 39, was admitted to the New York City Lunatic Asylum in May, 1880, when suffering from her first attack of acute melancholia. She had delusions of persecution and suicidal tendencies, was subject to exacerbations of excitement, during which she was violent and destructive until quieted by large doses of sedatives. In June, 1883, hæmatoma commenced in the left ear, which ran its course in two months without any particular treatment, leaving much deformity. On September 12th, 1883, othæmatoma commenced in the right ear; at first it was intensely red, but finally became purplish in appearance. No treatment.

October 31st.—The patient was examined by the writer and a considerable collection of fluctuating fluid was detected in a cyst, over an inch in length, on the outer surface of the right auricle. The fluid was evacuated by a free incision, the walls of the cyst painted with Churchill's solution of iodine, and the auricle bandaged to the head so as to cause a moderate amount of pressure. By November 3d the walls were adherent, and on November 9th the wound was found healing by granulation. When the writer last saw the ear, on No-

vember 23d, the sac was entirely obliterated. There was scarcely any deformity.

In some instances a sinus remains, affording a serous discharge which may continue for an indefinite period. The following is a case of this kind :

CASE III.—Annie M——, aged 35 was admitted to the New York City Lunatic Asylum, March, 1879, with acute mania. Soon afterward, on refusing food, was forcibly fed—the process consisting in placing the head of the patient under the left arm of the operator, while with his left hand a wedge is held in the patient's mouth, and with the right hand the feeding tube is inserted. Subsequently hæmatoma developed in the left ear. Although it seems probable that the ear was bruised during the forcible feeding, yet the patient was frequently engaged in fights with other patients at this time, when she was liable to receive blows upon the ear. There was no treatment, and the tumor passed into a chronic stage, which escaped observation until September, 1883, when serum was observed to ooze from an opening in the outer surface of the auricle just above the concha. This opening was enlarged and the cavity syringed out with a solution of carbolic acid with no result. On October 19th, the sac was laid freely open by the author, cleansed of the blood and other contents, and the walls thoroughly painted with Churchill's solution of iodine. Notwithstanding the employment of such pressure as was found to be practicable, the parts healed up again, leaving a small sinus as before. Subsequently the operation was tried three different times, but without avail.

November 23d —A slight sero-sanguinolent discharge remaining, it was concluded to try to obliterate the tumor by scraping its walls with a cutting scraper. The walls of the sac, however, which proved to be very large, consisted of broken-up and shrivelled cartilage, presenting rough and uneven surfaces. A partly detached plate of cartilage was found lying on the outer wall, and the edge of the superior portion of the helix could be felt. There was a deficiency in the cartilage composing the inner wall of the sac. It was evident that the irregularities of the walls had prevented adhesions of the surfaces from taking place.

Operation.—With a small sharp scoop every portion of the secreting surface was destroyed, considerable broken-down tissue being brought away by the instrument. The oozing of blood was quite profuse for a time. The parts were thoroughly cleansed with hot water, and pressure established by bandaging the padded ear firmly to the side of the head. No anæsthetic was employed. The parts healed kindly, pressure was maintained for some time afterward. After the first week there seemed to be some improvement, but when the patient was seen on December 22d, the cure was incomplete. (It is very evident that union could only be obtained between the walls of the sac in this case by dissecting out the irregular and detached masses of cartilage which prevent them coming together).

CASE IV.—Michael F——, 35 years of age; married; intemperate; entered New York City Asylum for the insane, with dementia, 1872. The accompanying cut is an excellent likeness of this patient.

The eyebrows have almost disappeared from constant rubbing; tries to rub his eyes out. November 24th, 1883, hæmatoma of the right pinna observed. Continually rubs side of head with stones and beats



FIG. 21.

himself. November 25th, the tumor on inner surface of auricle was incised. . . .

When the author saw this patient on November 27th, the right auricle was thickened, the outlines of the outer surface being almost obliterated. A large fluctuating abscess occupied the lower half of the inner surface of the pinna, and extended downward, spreading out over the mastoid process and involving the lobule (see Fig. 22).

It had been treated by applications of iced water. An incision, about half an inch long, was made into the lower part of the abscess, evacuating about a fluid ounce of pus.

It would seem that the post-aural abscess, although consecutive to the othæmatoma, was due to the constant bruising of the parts by the patient himself. The othæmatomatous tumor on the exterior surface

of the auricle probably gave rise to unusual vascularity in the whole organ, and there may have been an opening in the cartilage permitting the passage of the contents of the cyst into the connective tissue behind the ear, but there was no evidence of any separation of the perichondrium from the cartilage on its inner surface, and the con-



FIG. 22.

tents of the abscess apparently contained no serum. There was no history as to the exact duration of the othæmatoma.

CASE V.—Ignatius J——, aged 40, was admitted to the New York City Asylum for the Insane, August 18th, 1883, with dementia. A slight hæmatoma was observed to be developing in the left ear, October 28th. When examined by the author, the concha was much thickened as far as the meatus, in fact almost obliterated. No sacculated fluid was ever discovered.

The hæmatoma came on at the stage of mitigation of chronic meningitis, which fact is considered noteworthy. Its benign condition rendered treatment unnecessary.

CASE VI.—Joseph B——, admitted to the New York City Asylum for the Insane, May, 1883, was noisy and violent. About June 30th, two hæmatomas of considerable size developed. The left hæmatoma ruptured about July 9th. A month later, the left ear began to shrivel

up, reabsorption of the effused fluid taking place. When the author saw this patient, the ears had a shrunken appearance. Fig. 23 shows the deformity of the left ear.

CASE VII.—Hugh S——, aged 43, admitted to the New York City Asylum for the Insane, March 1st, 1881. He had hallucinations, was hard to control, and tore his clothing, etc., up to the time the



FIG. 23.



FIG. 24.

writer saw him, in January, 1884. Fig. 24 shows the condition of the left ear.[1] The history gives no account of the time of its appearance or progress.

CASE VIII.—Eliza ——, aged 30, admitted September 30th, 1882, with acute melancholia. On December 23d, slight redness and swelling of the fossæ of the left auricle was observed, the inner surface of the organ being unaffected. On December 24th the concha was invaded, occluding the meatus, and the ear was poulticed. The tumor increased in size until the 28th, when it was as large as a hen's egg. It remained stationary, the poulticing being continued until the 30th when it was laid freely open by a horizontal incision, evacuating a blood-clot and bloody serum. The cavity, which was about one

[1] The author is indebted to Dr. Trautman for the excellent photographs from which Figs. 21, 22, 23, and 24 were taken.

and a half inches long by one-half inch wide, was syringed out with carbolized water and afterward packed with oakum and balsam of Peru. December 31st a compress was applied. The outer surface of the auricle now presented a smooth, convex surface; the topographical outlines of the cartilage were absent, the concha and lobule even being indisguishable. The tragus was unaffected, but was in contact with the tumor. The swollen tissues were of a dark purple color. From the wound made by the incision there was constant and profuse oozing of sero-sanguinolent fluid, which trickled down the neck of the patient. The arms of the patient had to be confined to prevent further infliction of self-injury to the ear. Subsequently an abscess formed on the posterior surface of the auricle, and ruptured in that situation, the contents discharging from both anterior and posterior wounds. Gradual healing of the parts took place during January, the walls of the cyst uniting and the abscess healing by granulation. February 24th, ear completely healed. An examination in May showed the existence of considerable thickening in the superior portion of the auricle, with partial obliteration of the concha. The organ is not reduced in size apparently, although it has a shrivelled look, the outlines of the antihelix being distorted. The integument was not markedly adherent, and its color normal.

CASE IX.—Mrs. Barbara K——, aged 40, admitted July, 1883, with acute melancholia. Has delusion that devils are in her head and hallucinations of hearing. To prevent devils "crawling" into her ears and to exclude annoying voices, she thrusts foreign bodies, such as pebbles, rags, and the like, into her ears. On August 6th, the whole right exterior ear was observed to be intensely hyperæmic, but not thickened. The meatus externus, however, was occluded by swelling of its walls, and a little pus was found on syringing out the canal. On the 8th, the auricle was much more swollen, the markings becoming indistinct. Hot applications were made, and on the 9th pus flowed from the meatus freely. On the 13th it was observed that considerable purulent discharge was escaping from over the superior margin of the concha. Hot fomentations were employed, and the rupture healed by granulation about August 28th, leaving the cartilaginous portion of the external auditory canal occluded, the walls being in contact. The concha and fossa of the helix were obliterated and the tissues indurated; the auricle is greatly thickened and shrivelled. Hearing is unimpaired on this (right) side.

It will be observed that in two of the above cases there were complications attended with suppuration; in one of them—Case VIII.—this was due probably to contusions of the parts during the progress of the othæmatoma, and in the other case (IX.) the othæmatoma seems to have been caused by trauma and suppurative inflammation in the external auditory canal.

CASE X.—Female, aged 32. Has dementia, and is violent. On October 19th, 1882, the left auricle suddenly became the seat of a

hæmatomatous tumor the size of a pigeon's egg; it was of a dark purple color, and was situated on the outer surface. The swelling impinges on the concha, and occludes the external auditory meatus. Its progress was at first slow, remaining stationary for six weeks, when it again commenced to gradually increase in size without active inflammatory symptoms. There was fluctuation, but no pain; the skin was thickened, movable, and very much less discolored. Outline of helix remains, but antihelix and fossa obliterated; meatus more free. The posterior surface of the auricle was unaffected. Self-inflicted injury, due to the long-continued practice of violently pressing the ears with her hands, had doubtlessly given rise to the trouble. She always has numerous marks on the chest and elsewhere from self-inflicted injuries. The case progressed favorably from this time on, without any treatment, spontaneous recovery finally taking place.

CASE XI.—Patient, a professional gymnast, aged 35 years, had received, three weeks previously, a "cross-counter" blow upon the left ear with a gloved hand. This gave rise to no pain, but, two weeks later, the ear was again contused by a powerful blow from the foot of a person in training. The latter injury even caused no pain at the time, but twenty-four hours later, after exercising for two hours, the auricle was observed to be unusually warm and swollen.

The writer found, on examination, a tumor slightly pinkish in color, seated at the fossa of the antihelix; it had spread itself almost equally in all directions, encroaching considerably on the concha. It had partially refilled again, was "doughy" to the touch, but not tender. Hearing was unaffected. Half a drachm of straw-colored fluid was removed by aspiration, and the tumor was painted over with collodion, the patient feeling the pressure. Small doses of tincture of aconite were ordered, and rest was advised. The next day the tumor was softer, aspiration was repeated, and the treatment continued, with the addition of compression by means of padding of cotton-wool and bandaging. Tumor seemed to be *in statu quo*, effusion having probably ceased and reabsorption commenced.

It was found that the collodion contracting upon the tumor had made it quite tense and blanched in appearance, but that with each pulsation of the anterior auricular artery (which supplies the anterior surface of the auricle) the *entrance of the blood-supply was characterized by a glow of deep-red coloring, while the subsidence which succeeded to each distention was accompanied by blanching of the parts.* The pulsations of the temporal artery were visible above and in front of the tragus.

Treatment continued, excepting the aspiration. A few days later massage cautiously commenced. Progress was now uninterrupted, the massage being gradually increased in force and frequency. The collodion during the treatment was peeled off daily, and a fresh coating applied. Scarcely any deformity was observable at this time, but the concha was still smaller than normal, and the outlines of the antihelix were not sharply outlined. The patient, when discharged, was directed to continue the massage for some time.

CASE XII.—The othæmatoma was evidently caused in this case by the patient having *folded up the left auricle upon itself by an accidental blow with his own hand while playing with his child a short time before.* A small cystic swelling made its appearance on the upper and outer aspect of the auricle soon after. The patient was obliged to undertake a long journey shortly after coming under the care of the writer, on which occasion he contracted a severe cold. This was followed by fever, pains in the head, and an extension of the inflammation itself to the parts above the ear; also by effusion, both in front of and back of the cartilage. The patient was confined many weeks to his house. The cyst was laid open by a long incision, the wound being packed with lint soaked in carbolized oil. The auricle was yet quite tender to the touch, and sensitive to draughts of air even some five months later, although the parts had been for some time entirely healed. The author saw the patient about three years after this. It was found then that the auricle was considerably deformed, the superior portion of the cartilage being much contracted, the antihelix quite obliterated. It was evident that the long railway journey, the want of proper rest, and, above all, the cold contracted, made a severe case out of what would probably have been a mild one.

CASE XIII.—Patient came for treatment with a small sanguineous tumor on the outer aspect of the left auricle, between the helix and antihelix, near the superior border. The tumor was of a deep-red color, and slightly painful when handled. No urgent symptoms were present, and no subsequent visit was made.

CASE XIV.—Patient, a tailoress, aged 27 years, of very intemperate habits, stated that one month ago the left ear was violently jerked by her husband, and that the next morning it swelled up, and was of a very dark purple color. A day or two afterward the husband opened the swollen tissues with a blade of his pocket-knife. This operation increased the swelling, and a few days afterward a "doctor" laid the outer aspect of the tumor open with a lance. The cyst now became intensely swollen, and was as large as the patient's "fist." The husband then came home again in a drunken state, and struck her on the ear, causing a discharge of its contents to take place from the superior surface of the cyst. Flax-seed poultices were constantly applied to the ear during the attack. The posterior surface and the lobule were at no time affected. From the first the ear was for a while painful. The tumor was hard, about one inch in thickness, and from above downward one and three-quarters of an inch in length. It was oval in shape, its outer surface corrugated, and somewhat resembling an almond that has been divested of its outer cortex. It was not sensitive to the touch, and in color was dark red, like the rest of the face and neck. Hearing is unaffected. The ears naturally small. Fig. 25 shows the affected ear's appearance at the time of her first visit. The local treatment was expectant; internally the tincture of aconite root was ordered in small and frequently repeated doses. Rest and better personal hygiene recommended.



FIG. 25.

CASE XV.—Patient came with the statement that two months previously he had received an injury to the right ear by being jammed against a door while in a state of intoxication. Twelve hours afterward he experienced soreness of the auricle, which was limited to the upper part of the helix; this continued without observable swelling for six weeks. Two weeks ago he noticed that the outer aspect of the ear was "puffed out," and two days later an incision was made into it by a physician to whom he went at the time; there was an escape of sero-sanguinolent fluid, but by the next morning the incision had closed, and the cyst had refilled. Two days later another physician was seen, who cut the part open with scissors, and on the following day increased the size of the opening by making a crucial incision. It seems that these measures were not sufficient to prevent the filling

and distention of the sac, and that five days before a "piece was cut out," and the cavity then packed with oakum. Subsequently efforts were made to bandage the ear to the head. The oakum was allowed to remain for three days, and the ear was then poulticed. When the writer first saw the case the auricle was very much enlarged, had an angry look, and was of a purplish color. (See Fig. 26.) It was not very tender to the touch. Hearing was unaffected. It was very evident that the patient was in a state of chronic alcoholism, and he was told that treatment would be almost unavailing unless he left off the use of stimulants. The fluid which had again accumulated was now removed by aspiration, and it was determined to try pressure so soon as the necessary dressings could be borne. For ten days the improvement was uninterrupted; the fluid removed at each visit was found to be more and more thin and pale, and the quantity less and less.



FIG. 26.

The ear was not so angry in appearance, the outlines of the helix began to show themselves, and the sac diminished in size. The tissues were, however, considerably infiltrated.

The patient now resumed his intemperate habits, with the result of very much exasperating the condition of the ear, the organ becoming much worse after each debauch. Being unable to improve his habits in this regard, the treatment was finally suspended before a cure was accomplished.

CASE XVI.—Patient had his auricle twisted by another boy in a fight, a week before coming under the observation of the author. No pain or swelling of the auricle was remarked until four days after the injury, when a "throbbing pain," and some increase in the size of the auricle, were felt. There was found, on examination, a swelling, about the size of a Lima bean situated in the triangular fossa of the antihelix, on the outer surface of the right auricle. The inner surface

was unchanged. Both auricles were naturally large and loosely attached to the head. The tumor was tense and at first of a purplish color. At the beginning the tumor was aspirated and a few drops of blood were removed ; by means of pressure the contents were almost entirely evacuated, leaving it collapsed. Under treatment with local applications of collodion, at first almost daily, pressure-bandage and afterwards massage, the auricle resumed its normal condition in about seven weeks.

CASE XVII.—Chinaman, who stated that he had experienced pain in the upper part of the right auricle some three weeks before. The auricle also swelled and was tender to the touch. The swelling had increased steadily ever since. On examination it was found that the fossa of the helix and antihelix of the right ear were swollen and fluctuating. The swelling extended from the upper margin of the auricle to the spine of the helix. Posterior surface of auricle not involved. The habits of the patient were temperate and there was no history of trauma. He was accustomed, however, to sleeping on a board, and it is very probable that the auricle may have become contused by contact with this hard surface. Treatment was the same as in the other cases, and when last seen, the auricle was nearly normal in appearance.

CASE XVIII.—A youth, aged 19 years, came to the Infirmary on account of a purulent affection of the ear. On examination it was found that the concha of the right auricle was much deformed. The cartilage of this region was irregularly thickened, having a nodular feel. The skin was firmly adherent to both the anterior and posterior surfaces. The rest of the auricle was not involved. This deformity was caused by a twist of the auricle by the mother when he was a child. Immediately after the injury, the parts were swollen and a soft fluctuating tumor soon formed. The contraction of the perichondrium during the healing process had caused the deformity.

From the numerous cases of othæmatoma occurring among boxers which were examined by the writer, the following two cases were selected as good illustrations :

CASE XIX.—John F——, 29 years of age, intemperate, has been a boxer for ten years. Nine years ago he received a blow from "cross counter" upon left ear. The auricle became swollen, red, and tender, the pain extending all about the ear and down the neck. The tumor never opened, and became indurated in about one month. While the tumor remained "soft" it was repeatedly struck in boxing without other effect than slightly increasing the local sensitiveness. After recovery, which took place without treatment, constant bruising failed to produce a recurrence of the tumor. The outer surface of the left auricle is irregularly nodular—the fossæ being obliterated and the outlines of the ear completely destroyed, with the exception of the helix, which was not affected. The auricle is about three-fourths of an inch thick, and the concha is reduced in size, due to thickening

of antitragus. The posterior surface is normal. The ear never discharged, and hearing is good.

CASE XX.—Thomas A——, 26 years of age, has been a boxer for many years. Received a blow upon left ear from "cross counter" three years ago, producing a soft, tender swelling of the ear, and much pain in the organ and side of the head and down the neck. There was also a "numb" feeling, and autophonia, which remains. Hot milk and slippery-elm poultices were applied. The tumor was at first purple in color, afterward it became red. It remained "soft" for a period of five months, during which time it was frequently ruptured by blows. Afterward it became hard and deformed. The auricle is smooth, all of the markings being obliterated except the anterior portion of the helix which is normal, and is fully one inch in thickness. The pinna seems folded upon itself from above downward. The concha is impinged upon from behind, leaving a mere slit in front of the meatus externus. There is some deafness in the left ear, due doubtlessly to the blow upon the organ. The resulting deformity is similar to that shown in Fig. 24.

The occurrence of othæmatoma in the mentally sane is uncommon; a glance at the literature of the subject shows that it has been comparatively seldom the subject of observation among foreign writers, while American authors have thus far reported only some ten cases.[1]

The following table, showing several important points in the author's nine cases among the mentally sane, it is hoped will not be without interest.

No.	Age.	Sex.	Occupation.	Ear affected.	Habits.	Cause.
1	43	M.	Negro-minstrel	Right.	Temperate.....	Trauma.
2	35	M.	Gymnast	Left.....	Temperate..... ...	Trauma.
3	43	M.	Lawyer.....	Left.....	Temperate..... ..	Trauma.
4	40	M.	Packer	Left.....	Temperate..... ..	Trauma (?).
5	27	F.	Tailoress.....	Left.... ...	Intemperate.....	Trauma.
6	25	M.	Merchant.....	Right.....	Intemperate.....	Trauma.
7	12½	M.	Schoolboy.....	Right... ...	....	Trauma.
8	44	M.	Laundryman....	Right.... ..	Intemperate	Trauma (?).
9	5(?)	M.	....	Right... ..	....	Trauma.

[1] Vide C. J. Blake: Statistical Rept. of 1,632 Cases of Diseases of the Ear, treated at the Mass. Ch. Eye and Ear Inf. during the year 1872: one case of othæmatoma—A. J. Otol., vol. iii., pp. 193–196. H. Knapp: Arch. Otol., vol. ix., pp. 195–202. Roosa: Trans. Am. Otol. Soc., vol. i., pp. 23–127. Kipp: Trans. A. O. Soc., vol. i., p. 79. Pomeroy: Ibid., vol. ii., pp. 83–86. Buck: Diagnosis and Treat. of Ear Diseases. Pooley: Medical Record, vol. xix., pp. 313–315.

From the foregoing it will be observed that the cause of the lesion in seven cases was traumatic; in two cases the history in this respect was incomplete. Eight of the patients were males, only one a female. The hearing, as will have been seen in the histories given, was unimpaired in any of these patients.

OTHÆMATOMA IN THE LOWER ANIMALS.

This form of disease is said to affect dogs, an account of its occurrence in whom has been given by Mr. S. Ogier Ward.[1] Wilde states that he observed the trouble in a valuable pointer. The writer has never seen a well-defined case of othæmatoma in a dog, unless isolated hard lumps in the pendent portion of the organ be such. It would seem that some shrinking of the auricle would be produced by perichondritis rather than the "lumps" alluded to by writers.

The cat, it would seem, is liable to othæmatoma, an example of which was shown to the author. The animal (a male) which was the subject of the trouble was of the Angora strain, and was one year and a half old. He was a fine example of the kind, and, perhaps owing to high breeding, very excitable, not to say wild and uncontrollable.

Over two weeks before the entire inner surface of the left auricle had been swollen out, the affected organ forming a long, pointed tumor. The effusion was gradually reabsorbed, and when the writer examined the ear afterward, it was smaller than the right one, and somewhat thickened and shrivelled. The presence of some cutaneous trouble in the post-auricular region and over the vertex was noted. The auricle had assumed its natural color. Subsequently to the above, the right auricle became affected in the same way the left had been. There was no evidence of the auricle having been scratched.

The writer has frequently examined the ears of pugilistic cats with ears deformed by lacerations produced by biting and scratching, but has never before met with an example where deformity characteristic of perichondritis existed.

GUNSHOT WOUNDS.

The number of gunshot wounds of the ear occurring in modern warfare is very great. It is stated[2] that the number of wounds of the head from all causes, in the Civil War, was 12,980; of the face,

[1] Loc. cit.

[2] Medical and Surgical History of the War of the Rebellion. Part First. Surgical Volume.

9,815; and gunshot wounds of the neck, 4,895. The greater number of the head and face wounds were, of course, made by musket balls.

Out of this large number of casualties, viz., 27,690, examples of many especially interesting cases were selected by the editor, the late Geo. A. Otis, then Assistant Surgeon U. S. A., from the records of the Surgeon-General's office for publication in the great work mentioned.

An examination of these selected cases by the writer, for the purpose of ascertaining the frequency and extent of aural injury either direct or in cases of severe wounds in the immediate vicinity of the ear, shows that this organ is seldom more than incidentally or vaguely alluded to even, and that no attempts whatever, worthy of mention, were made to differentiate complicated wounds of the organ. In reviewing the literature offered in the national work mentioned, with the object stated in view, the enormous labor of classification, it should be stated, seems to have been done with great fidelity and industry, and, when the material at hand is considered, it should also be said, satisfactorily. On looking back, moreover, from the present point of view to the period when so many medical men went into the field with scarcely any preparation for special work, it must be borne in mind that too close scrutiny of the results is not fairly admissible. In the examination of this vast store-house of military surgical history one cannot but feel, however, that by far the greater part of the surgical history of the late war was lost because of the utter impossibility of the proper records being kept by the medical officers in the field, and in consequence of their inexperience in many of the special departments of surgery. The mass of material which has been placed at our disposal was of so complex a character that precise classification was found to be impossible. There could have been but little experience at best in military aural surgery, since otology was almost in its infancy when the war began in 1861.

However much, then, the otologist of to-day may regret that wounds and injuries of the ear were not more frequently reported in detail by the military surgeons who could have observed them, the facts just stated seem to explain sufficiently the meagreness of the results. Undoubtedly the statistics bearing on this subject would have been much fuller had not a large number of injuries, including many of the ears, been overlooked,[1] for the temporal bone or its exterior attachments are scarcely ever seriously injured without impairment of the hearing organ in some degree. A careful search, however,

[1] Wounded prisoners and absentees would double the number.

among the various abstracts published has not been without profit, inasmuch as it has been thus found that wounds and injuries of the head, face, and neck give rise very frequently to impairment of hearing. The subject, therefore, assumes much greater importance than it would obtain from a mere statistical standpoint, and especially so if the maiming and deformity are considered, since both justice and humanity demand that the deserving soldier should not be prevented from obtaining a proper pension on account of any neglect in medical examinations for either discharge from service or in applying for a pension.

The valuable contribution to military surgery, to which allusion has been made, gives only sixteen cases of ear injury from gunshot contusions of the skull. These have been classified, somewhat indefinitely, under the general head of "deafness," and embrace all the injuries of this kind that could be collected from the reports in the Surgeon-General's office.

It was found that none of these cases were fatal, and it is, furthermore, an interesting fact that in some instances the missile entered at a point remote from the ear, but involved the organ in its course. Dr. Otis, unfortunately, found no time to arrange the material in the Surgeon-General's office so as to more completely bring out all the points of interest in connection with aural complications; indeed, the painstaking efforts made to classify gunshot injuries, in a more general way even, was a work of great labor. A few remarks were made, however, under "wounds of the ear," which will be considered further on.

A careful collation of the material scattered throughout the surgical volume, in various sections, brings to light some interesting cases. The following is found under "Disabilities Following Gunshot Fractures" (also alluded to in "Wounds of the Ear").

Lieut. Wm. S. Simms, 82d N. Y. Volunteers, was wounded at the Battle of the Wilderness, Va., May 6th, 1864, by a conoidal musket ball, which penetrated the left mastoid process, leaving a small external opening, and injuring, it is stated, the "internal" ear. "The missile, which was removed on the field, had become elongated." He was speechless for ten days, and his intellect was subsequently found to be greatly impaired. On partial recovery, about two months after the injury, he was transferred to the 59th N. Y. Volunteers as major, and was mustered out of service one year later, the wound being still open, the left side of the face partially paralyzed, and with partial hemiplegia of the right side. In 1871 he was examined by the Pension Board in New York, when it was found that there was a large opening in the temporal bone "one-half an inch in diameter and two and one-half inches in depth, forward and inward, and con-

necting with the ear." The facial paralysis and hemiplegia remained, and deafness was said to be complete. It was believed that some inflammation of the brain existed, and that a fatal termination was to be expected.

Note.—The writer saw Mr. Simms, who has resided in the Bloomingdale Asylum for some time past, in November, 1883. He is now well-nourished, but owing to the right hemiplegia, the right side is much smaller than the left, and he limps in walking. The facial paralysis is still present, but gives him less trouble than formerly. Mastication can be performed on the left side to some extent, although the teeth on both sides are very defective, many of them being absent. The inability to close the left eye gives him but little trouble unless dust or strong draughts of air strike it. He has been able to breathe quite well through the left naris for the past year (previously it was collapsed). He has no pains anywhere excepting in the right foot, the toes of which are in a state of contraction.

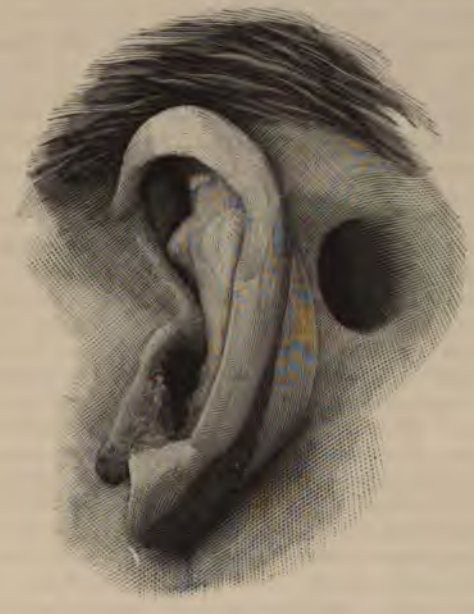


FIG. 27.

Examination of Ears.—Right ear, large external auditory canal. The drum-head is greatly retracted over the short process, and in consequence has numerous folds, a result of defective development. Hearing in this ear is very good.

The left ear, which was injured, presents the following appearances: Large auditory meatus. There is an oval opening (see Fig. 27) about one-half an inch in diameter, just behind the auricle, its

lower wall a little above the floor of the external auditory canal. Its lumen does not face directly inward, but rather forward. With reflected light, and without a speculum, a large pathological cavity may be seen, embracing all of the space formerly occupied by the pneumatic cells of the mastoid and the tympanum. This cavity is lined throughout by a whitish dermoid membrane of new formation, excepting at the roof, where there is still some inflammatory action in progress, the parts being covered by a rather thick and closely adherent crust of inspissated pus. This cavity, measuring forward from the opening behind the ear, is about one inch and a half deep, which brings the probe within a line or two of the carotid canal. A probe passed into the external auditory canal and across the cavity described strikes the inner wall of the tympanum at the distance of one inch and an eighth.

The wound of entrance was small, it is said, and the ball when removed was elongated. In reviewing the history of the case, it would seem probable that the missile had become elongated before its entrance by coming in contact with some object, which also broke somewhat the force of impact, since any resistance offered by the cortex of the mastoid would have been likely to flatten out the ball. A ball, moreover, of unchanged diameter and greater momentum at the moment of its initial resistance would have produced much more serious consequences. Judging from the present appearance of the parts, the missile passed through the upper portion of the pneumatic cells of the mastoid, and, passing along forward in an almost horizontal direction, carried away the inner extremity of the external auditory canal on its outer side, and scraped the inner wall of the tympanum on the inner side of its track. In wedging itself in the narrow bed offered by the parts penetrated, the upper surface of the ball lifted up the tegmen tympani, while its anterior extremity almost penetrated the carotid canal. The transmitting mechanism and a portion of the facial nerve were, of course, entirely destroyed, unless, indeed, the round window and foot plate of the stapes were left in a mutilated state. The carious process, in the mastoid cells, as sometimes happens in purulent inflammation of the parts consequent to otitis media, must have gone on until this structure was entirely broken down. Minute sequestra came away until two years ago. The healing process has been going on here for the past nineteen years, almost unaided by treatment much of the time. The protective provisions of nature here prevented the destructive processes from breaking through the walls of the carotid artery, the lateral sinus, and the dura mater above the roof of the tympanum. The crust lying upon the tegmen was lifted up by a probe, exposing a thick pultaceous mass beneath. This the writer did not remove, although the thought occurred to him that the monthly epileptic attacks, with very decided maniacal symptoms, to which the patient is now subject, might in some measure be influenced by accumulations of pus, which distend the parts up to a certain point before finding a vent through partial detachment of the crust. Some local meningeal irritation probably remains at this part. The patient syringes his ear once a week, and with an ear-scoop removes any accumulations

in the cavity or from the external auditory canal. The distressing tinnitus aurium, like escaping steam, which was once so very annoying and constant, is now infrequent and scarcely noticeable.

There seems to be some considerable hearing in the affected ear, the exact amount of which, however, is very difficult to determine. His memory is greatly impaired.

The above case is of much interest, inasmuch as the wounding of the mastoid and tympanum gave rise to a condition of things resembling cases quite often seen in practice, arising from neglected mastoid disease consequent to otitis media.

The severe shock to the brain and fracture of the tegmen tympani at the moment of injury, characterized the gunshot wound described.

The following three cases are not classified either under "deafness" or "wounds of the ear," but as it is probable that the hearing was affected in all such cases, they will be introduced here.

"Capt. Winfield S. Barr, Co. B., 105th Pennsylvania Volunteers, aged 23 years, was wounded in an engagement before Petersburg, Va., August 16th, 1864, by a conoidal ball, which *fractured the mastoid process of the temporal bone,* and injured the base of the occipital." "On December 7th, *several spicula of necrosed bone came away,* and on December 30th, a *large portion of the mastoid process was removed.*"[1] Captain Barr was subsequently mustered out of service and "in May, 1885, he was a pensioner, and his disability was rated as total and permanent."

"Sergeant Lyman A. P——, Co. D., 8th N. Y. Heavy Artillery, aged 21 years, who was wounded at Ream's Station on August 25th, 1864, by a musket ball, *which entered over the right mastoid process, injured the external ear,* and lodged under the skin, a little in front of the auditory foramen."[1] "The ball had not been extracted, and no symptoms attracted special attention until September 7th when Acting Assistant Surgeon A. M. Sherman, in charge of the case, observed that the right parotid gland was so greatly inflamed that the patient with difficulty separated his teeth more than one-fourth of an inch." Subsequently, ligation of the right primitive carotid was performed for supposed hemorrhage from the posterior auricular. "The ligature was placed a short distance below the bifurcation, and coagula were removed, and the ball, already mentioned, was extracted from near the angle of the jaw." The patient, however, died from subsequent hemorrhage, on the eleventh day after the operation. The condition of hearing in the affected ear is not noted, nor is the character of the injury of the ear mentioned.

[1] Italics are the present writer's.

The following case is related under wounds and injuries of the neck.

Private Frank Eastman, Co. C., Sixth New Hampshire Volunteers, aged 18 years, was wounded April 2d, 1865, by a fragment of shell, which *entered near the spinous process of the seventh cervical vertebra and emerged in front of the ear on the right side.* He recovered from the injury and was discharged from service on July 24th, 1865. When Pension Examiner C. H. Boynton reported on the case, November 13th, 1865, *the patient suffered from deafness in the right ear, and from pain and dizziness.* It is stated that there was a continuous discharge of matter into the mouth which was believed to come from the ear through the right Eustachian tube. The patient was unable to labor. The wood-cut illustrating this case, on admission to Harwood Hospital, Washington, a few days after the wound was received, shows that the wounds of exit and entrance were greatly lacerated, and were in a sloughing condition.

It would seem that in this latter case, caries of the mastoid cells or of the osseous walls of the tympanum must have existed, and that there was some obstruction of the external auditory canal which prevented an escape of the secretions.

The following case of gunshot wound of the face, implicating the ear, came to the author for treatment, November 26th, 1877, on account of an acute purulent inflammation of the middle-ear. It illustrates well the disadvantage of partial closure of the external auditory canal in preventing the free escape of secretions from the middle-ear.

John Farlow, Company D., 11th N. Y. Volunteers, aged 20 years, was wounded in the face, July 21st, 1861, at Bull Run, by a ball which entered just below the outer angle of the right eye, and after passing through the malar bone, at its articulation with the superior maxillary bone, ranged directly backward and slightly downward through the masseter muscle and lodged in the temporal bone above the glenoid fossa. The missile was probably a rifle ball. It may now be felt lying beneath the integument lining the external auditory canal. Soon after getting up he found that the hearing of the right ear was greatly impaired.

When the author examined this patient, the watch only could be heard $\frac{P}{3.3}$. Vision of the right eye was almost gone. An examination of the inner end of the canal and of the membrana tympani could not be made, owing to the presence of the missile which is very probably encysted.

No report of this case can be found in the "Medical and Surgical History of the War of the Rebellion." It is believed that a very large number of the wounded in this engagement were never reported to the Surgeon-General's office.

The editor of the "Medical and Surgical History" selected a large

number of cases of wounds of the eye from the reports. One thousand one hundred and ninety cases of gunshot wounds of this organ are thus classified as occurring in "wounds and injuries of the face." There are two hundred and ninety-three "selected cases" of which abstracts are given. In two hundred and fifty-four cases of this number, one eye only was injured, however, and among these were thirty-nine cases of fracture of the temporal bone, or other injury implicating the ear. One can readily understand how a bullet coming from the front, or nearly so, could wound not only the eye, but the ear also; and it is difficult to avoid the conclusion, from the perusal of these briefly reported cases, that had more detailed examinations and reports been made, a larger number of aural injuries would have been selected.

Wounds and injuries of the jaws and other facial bones, as was to be expected, frequently involved the ear. Where the lower jaw is injured, the concussion imparted to the glenoid fossa may give rise to inflammation of the temporo-maxillary articulation, with consequent inflammation of the osseous and periosteal structures of the contiguous portion of the external auditory canal. Stenosis of the canal may thus be brought about, with exclusion of sound; or an extension of the inflammation to the transmitting mechanism of the middle-ear may occur, giving rise to altered tension in the drum-head, or otherwise injuring this part of the ear.

An analysis of the one hundred and thirty-five cases of gunshot fracture of the facial bones, abstracts of which were made, shows that the ear was injured in seventeen cases—eight by wounds of entrance, and nine by wounds of exit. The wounds of entrance are described as follows: In one case, a musket ball entered "in front of the external auditory canal of the left side;" in a second case, the missile entered "close to the mastoid process" of the right temporal bone; in another, "behind and above the lobe" of the right ear; in a fourth, "one and a half inches below the ear;" in the fifth case, "in front of the left ear;" in another, "two inches behind the left mastoid;" in another, "below left ear;" in an eighth, "just anterior to the tragus" of the left ear.

The wounds of exit were stated to have been as follows: One by "two openings in front and below the pinna;" one "at the left ear;" another "behind the right ear;" another "two inches behind left ear;" a fifth "emerged, tearing away a portion of the lobe" of the left ear; one "emerged one inch below lobe of right ear;" one "lodged below mastoid in exit" at right ear; another "escaped one inch below

the ear" on the left side; and one "emerged an inch behind lobe of left ear."

The above illustrates very well the various channels of approach to the ear. The left ear, it will be observed, was injured in nine cases, and the right ear in eight cases. In the eight wounds of entrance, the left ear was injured in five cases and the right ear in three cases—showing the same increased frequency of left-sided wounds as in head wounds. In the wounds of emergence, the right ear was affected in five cases, the left ear in four cases.

Facial paralysis occurred as a result of these injuries in three cases—in two instances the facial nerve was apparently injured in its passage along the *aquæductus Fallopii*, and in the other after its emergence from the stylo-mastoid foramen. The result of the injuries was fatal in five cases. In six of these cases only is mention made of any deafness being produced; indeed, in the whole group thus classified as face wounds, the ear is alluded to only in the most incidental manner. In one case, the sense of taste was affected. In two of the cases, discharge from the ear was noted—the same being purulent in the one case and serous in the other. Vertigo was pronounced in one case.

Circular No. 3 of the Surgeon-General's office, which embraces the reports of the medical officers for the period of time extending from the close of the war of the Rebellion, in 1865, down to 1871, contains some contributions of interest to the otologist. The following case is reported by A. A. Woodhull, Assistant Surgeon U. S. Army:

Soldier, accidentally wounded near Fort Gibson, Nov. 8th, 1868. The ball entered the side of the neck, traversed the mastoid process, and passed through the external ear; "the bone was slightly injured, and the external ear nearly destroyed." "He was treated in hospital at Fort Gibson, Cherokee Nation, until Feb. 18th, 1868 (1869?), when he was sent to join his company." The wound was nearly healed, excepting some little amount of discharge. Partial deafness also existed.

David Walker, Acting Assistant Surgeon, reports the following case:

A cavalryman, aged 22 years, was wounded in an Indian fight, September 6th, 1865. "It was found that he had a gunshot wound, the ball having entered at the posterior head of the sterno-cleido-mastoid muscle, close to the curved line, ranging outward and a little upward, and lodging in the mastoid process. There was considerable hemorrhage from the auditory canal, with temporary deafness,

and paralysis of part of the *portio dura* of the seventh pair. Ultimately the recovery was complete."

The literature of military surgery of the present century does not, naturally enough, contribute much to the science of otology. A perusal of Guthrie's "Commentaries"[1] fails to discover but a single allusion to wounds or injuries of the ear. Hennen,[2] however, devotes a paragraph to the subject, and narrates one case of wound of the head where a musket ball entered the right temporal bone and lodged in the brain, causing "partial deafness of the right ear," among other symptoms. He says: "The ear is the subject of gunshot wounds, as various as the eye, in their course and in their effects. The mastoid process is injured sometimes in its whole extent, and sometimes only partially brushed; the balls passing about it in every possible angle, and sometimes appearing even to enter the external meatus itself; at all events, injuring the bony circle primarily, and in its consequences implicating the more internal bony sides of the auditory canal, and small bones of the organ, in suppuration and caries. These cases are attended with more or less deafness, great pain, frequent spasmodic affections of the face, and an intolerable fetor in the discharge; and are sometimes followed by death from inflammation spreading to the brain."

Guthrie, under "wounds of the face," treats somewhat of lesions of the ear. These will be alluded to hereafter.

Macleod[3] very briefly and incidentally mentions four cases where the ear was injured by musket balls.

In one, "a French soldier received a ball about an inch behind the left ear;" in another case the ball "entered two inches behind the left ear, passed deeply, and was removed from the temple," and there was hemorrhage from the ear. "He made an excellent recovery, only that his hearing was destroyed on the wounded side."

Another case is given under wounds of the head, in the appendix:

"Compound fracture of the squamous portion of the left temporal. Bleeding from the ear. Deafness complete on left side, and partial on right. Had headache, and a stupid, vacant expression of face when sent to England."

[1] Guthrie, G. J., F.R.S.: Commentaries on the Surgery of the War in Portugal, Spain, France, and the Netherlands, from the battle of Roliça, in 1808, to that of Waterloo, in 1815, etc. Revised to 1853. Fifth edition. London, 1853.

[2] Hennen, John, M.D., F.R.S.E.: Principles of Military Surgery, etc., page 279. First American from the third London edition. Philadelphia, 1830.

[3] Macleod, George H. B., M.D., F.R.C.S.: Notes on the Surgery of the War in the Crimea, etc. 1862.

In another case a ball was "partially impacted a little above and behind the right ear," the patient subsequently succumbing to hernia of the brain after trephining.

Moos[1] reported three cases of gunshot wounds of the ear, all of which will be found of much interest.

A soldier was wounded at the battle of Wörth, August 6th, 1870, in the left ear and in the right knee. The ball which wounded the ear "glanced over the soft parts in front of the tragus and the tragus itself, and had produced a shallow, granulating, pretty large loss of substance before the left ear; it had torn away the skinny and cartilaginous part of the external auditory passage in such a way that the posterior wall of the osseous canal was struck where the same is joined to the mastoid process." There was partial splintering of the bony parts, suppurative inflammation of the external and middle ear, and subsequently peripheral necrosis of the mastoid process followed, with burrowing abscess extending down under the sterno-mastoid muscle. The track of the ball after it entered the cells of the mastoid process could not be traced, and the ball was not found. The sense of hearing was completely lost. Patient underwent amputation of the thigh for suppuration of the knee-joint, and died on the 6th of September, 1870. Examination of the temporal bone showed that the posterior wall of the osseous canal had been splintered by the passage of the ball, and that the opening led into a cavity in the mastoid, the size of a hazelnut. Downward from this cavity a sinus extended into the tissues below. The tissues of the middle and inner ear were more or less inflamed.

Inasmuch as no facial paralysis occurred in this case, we may infer that the injury was confined to the posterior wall of the canal and outer and lower portion of the mastoid body, the middle ear becoming involved through extension by continuity. It seems probable that recovery would have taken place here, so far as the wound of the ear was concerned at least.

The second case was examined by Moos four months after the injury had been received:

Soldier wounded at the siege of Strasbourg, September 20th, 1870, by a Chassepot ball in the left ear from behind forward, the missile entering on the lower half of the mastoid process, and emerging on the left side of the face, just in front of the external meatus and cutting away the tragus. Paralysis of the muscles of the left side of the face resulted. "The perception of the direction of sound was completely lost, and at first was very distressing to the patient, as he constantly thought every sound came from the right side; by degrees he learned to correct this." Tuning-fork on skull was perceived only on the sound side, but he heard the watch on temple. Moderately loud words spoken through a trumpet were not heard.

[1] Archives of Ophthalmology and Otology. Volume II., No. 1, 1871.

The clinical history in this case is incomplete: On being struck, he immediately fell to the ground, became unconscious, but gradually and completely regained his faculties during the next twenty-four hours. The first six days he suffered from violent pains in the forehead and occiput. He had, however, "no subjective sensations of hearing," but for several weeks now and then knockings in the depth of the ear; about two weeks before the above examination was made, however, he began to experience tinnitus aurium, which still existed.

Prussian soldier, wounded on the Lisaine, January 18th, 1871, by a ball which "struck the right ear, and passed below the left side of the lower jaw, and came out." The only injury resulting from this appears to have been in the cartilaginous meatus, the lower wall of which was slightly lacerated.

Mossakowski[1] found among 1,415 wounded French prisoners but 14 wounds of the bony parts of the head. Of this number the forehead was the seat of the injury in 1 case, the parietal bones in 10, and the temporal bone in 3 cases. In 4 of these cases severe cerebral symptoms developed, and in 4 of them hemorrhage from the ear occurred. Objective examination showed that of these 14 invalids, 4 were deaf in one ear, whilst 2 were deaf in both ears, with severe psychical disturbance. Special aural examinations of these patients were apparently not made.

G. Fischer[2] places the number of gunshot wounds occurring in the Franco-Prussian War at 88,877. According to this author, the head was the seat of injury in 8,132 cases, the face in 1,440 cases, the eyes in 464, the nose in 216, the mouth in 365, the chin and lips in 348, and *the ears in* 303 *cases* (0.34%).

In examining a recent work on "Military Surgery" by H. Fischer,[3] the writer finds some very instructive cases of gunshot injuries of the ear, which have been collected from the reports of different authorities.

We find that F. Löffler observed five cases of gunshot wounds of

[1] Mossakowski, Paul: Statistischer Bericht über 1415 französische Invaliden des Deutsch-französischen Krieges, 1870–1871. Deutsche Zeitschrift für Chirurgie, Band I., 1872.

[2] Fischer, Georg: Statistik der in dem Kriege 1870–71, im preussischen Heere und in den mit demselben im engeren Verbande gestandenen Norddeutschen Bundes-Kontingenten vorgekommenen Verwundungen und Tödtungen. Berlin, 1876.

[3] Fischer, Prof. Dr. H.: Handbuch der Kriegschirurgie, Band I., Stuttgart 1882.

the mastoid process and bony canal, all of which were received on the 18th of April, 1864, at the storming of the Danish intrenchments at Düppel by the Prussians.

Fischer mentions also two cases reported by Beck, in one of which the ball, passing through the mastoid process, penetrated deeply into the petrous portion of the temporal bone, fracturing the base of the skull, and eventually causing death; in the other case the missile entered the external auditory canal and lodged there, extraction being followed by recovery.

Another case, observed by Stromeyer, as follows:

Patient received a bullet at a short distance in the left side of the head, the lobe of the ear being slightly injured thereby. On the mastoid process was a small wound. The point of the finger being introduced, found the whole mastoid to have been completely shattered. Eventually the whole process was exfoliated, and the patient recovered with not the slightest impairment of hearing.

We find also an interesting case of Dudon in this work:

Patient, 17 years of age, had received a ball from a carbine in the right ear four and one-half years before. The cerebral symptoms which followed lasted but a short period, and nothing remained excepting a discharge from the ear. When Dudon examined the patient, he found the canal filled with granulation tissue. The bullet was easily found and extracted. The drum-head was completely destroyed and hearing entirely gone. Patient recovered with loss of hearing.

The following is a very remarkable case, reported by Luecke:

Soldier, wounded in the Second Schleswig-Holstein war, at Alsen, June 29th, 1864, by a small canister shot, which entered in front of the left ear at the height of the helix, tearing a large hole in the squamous portion of the temporal bone. Out of this wound, and also out of the external auditory canal oozed a very considerable amount of blood and brain substance. The missile appears to have passed downward, completely shattering the petrous portion of the temporal bone, and was found just beneath the skin near the spinous process of the fourth dorsal vertebra. Patient was able at first to tell his name and the number of his regiment, but soon lost consciousness. "After prolonged suppuration and extraction of many pieces of bone, he was discharged as an invalid in January, 1865, having no other lesion excepting paralysis of the facial and acoustic nerves." His intellect, however, appears to have suffered severely, and his life during the following four years or so was a miserable one. He was found frozen to death in the woods finally.

Two cases of Löffler's, given by Fischer in his work mentioned above, are of much interest:

Soldier, wounded in the Schleswig-Holstein War, the ball entering the right external meatus, passing through the posterior wall of the latter and also through the mastoid process, behind which it was found and removed. Complete facial paralysis and deafness, also loss of bone conduction and protrusion of the right orbit, resulted. Patient recovered eventually with loss of hearing and of vision on the right side and facial paralysis.

Soldier, wounded on the 18th of April, 1864, at Düppel, by a bullet which entered just in front of the right ear, shattered the mastoid and was, at the autopsy, found lodged between the latter and the jaw. The last mentioned bone and the styloid process were also shattered. Patient died on the 15th day after the injury, from purulent meningitis. The petrosa was found to be fractured.

Fischer finally gives the following case, as illustrating the danger by which such patients are constantly surrounded, as long as a discharge from the ear exists :

A sergeant, wounded on April 18th, 1864, in Schleswig-Holstein, by a bullet which penetrated just in front of the left ear, shattered the zygomatic arch and passed through the external auditory canal, fracturing the drum-head, and perforated also the mastoid process, becoming finally lodged in the neck near the fourth cervical vertebra. Facial paralysis and complete loss of hearing resulted, with which the patient was eventually discharged, a slight otorrhœa being also present. About a year after this he had an attack of convulsions, having experienced for some days previously pains in the head and ear. He died the following day from purulent meningitis, with abscess of the brain. Partial necrosis of the petrous portion of the temporal bone existed and also an ununited fracture of the same bone.

Gillette, in speaking of the wounds made by firearms, mentions the fact that bullets occasionally lodge in the petrosa, and cites a case reported by Lecoin, who found the ball lodged in the interior of that bone. Gillette[1] also mentions a case observed by Guyon, of a young woman with facial paralysis consecutive to a revolver shot fired into the ear, the missile being then firmly lodged in the petrosa. Otherwise the patient was perfectly well.

The above citations embrace about all that the author has been able to obtain from the works on military surgery at hand, concerning gunshot injuries of the ear, with some few exceptions to which allusion will be made later on.

Now and then opportunities have been afforded for observation of self-inflicted gunshot wounds of the ear, this organ seeming to be one

[1] Gillette : Remarques sur les blessures par armes à feu observées pendant le Siége de Metz (1870) et celui de Paris (1871). Archives générales de Médecine. Vol. I., Paris, 1873.

of the favorite channels for discharging a missile into the head by the suicide. Out of eleven cases of suicide by gunshot wounds of the head, reported in Circular No. 3 of the Surgeon-General's Office, 1871, four of them were from shots in and about the ear. All gunshot wounds of the ear are liable to have other injuries associated with them and may therefore come under the care of the general surgeon, and detailed reports of them are not often given. The above examples of fully described cases are therefore introduced on account of their particular instructiveness.

Prof. Geo. E. Post,[1] M.D., of Beirût, Syria, reports a case of much interest.

The patient, a man 22 years of age, was asleep when a revolver was accidentally discharged directly into his right ear by his little brother. He experienced the sensation of being awakened by a clap of thunder. Copious hemorrhage from the ear, severe headache, impairment of hearing and distressing tinnitus aurium followed. There was considerable febrile action, and for weeks the symptoms were grave. When he finally recovered sufficiently to leave the house, he was still quite unable to resume his occupation (tailor). Efforts made in Damascus by the military surgeons to remove the ball from the meatus by means of forceps and the screw tire-balle, were unsuccessful, and although particles of lead were removed, the bullet was not disturbed in the slightest degree. The patient was, when seen by Post, suffering from hemicrania, dizziness, tinnitus, otorrhœa, and an inability to concentrate his attention on any subject. The bullet was felt at the end of the meatus, but could not be moved. Believing the ball to have been impacted in the mastoid cells, it was decided to remove it by an operation. The pavilion was dissected free along its mastoid border, and separated from its deep attachments, the dissection being also carried behind the meatus externus until this was quite free from the mastoid process. "It was then divided from behind forward, along the line of junction with the bony meatus, and the pavilion, with the cartilaginous portion of the meatus, were turned forward on the cheek." "The posterior bony wall of the meatus was found shattered by the bullet, which was then plainly seen, filling the cavity of the tympanum, and extending by many ragged projections back into the mastoid cells." Attempts to dislodge it with the forceps and the tire-balle were fruitless. The bullet was finally removed after the mastoid process had been trephined. Patient made a good recovery in three weeks, being relieved of all his grave and distressing symptoms.

A case of compound fracture of the petrous bone, caused by a revolver bullet, is reported by Mr. E. M. James.[2]

A man, aged 25 years, shot himself in the right ear with a revolver.

[1] New York Medical Record. October 26th, 1878.
[2] Australian Medical Journal. September 15th, 1880.

There was severe primary hemorrhage. Mr. James found a lacerated wound at the bottom of the concha of the right ear. The adjacent parts were blackened, blood oozed freely from the wound, and there was facial paralysis of the right side. There was marked hyperæsthesia about the shoulders, especially on the right side. Motions of the limbs unimpaired. A probe introduced into the wound passed inwards and slightly backwards to a depth of half an inch. It was found that the track of the ball lay inwards and slightly forwards. The ball, not being felt, was supposed to have passed into the cranium. The mastoid was then trephined from behind forwards on to the point of a probe inserted through the original wound. The bullet could not, however, be recognized by the probe introduced along the opening made by the trephine, and further search was abandoned. Patient was conscious some of the time at first and suffered much, but afterwards became delirious and sensitive to light and noises. On the sixth day, the discharge from the ear was very great; death on the seventh day. At the autopsy, it was found that "a bullet, weighing nearly a quarter of an ounce, had passed through the concha of the right ear, involving the external meatus; it then penetrated the skull, and running inwards had struck against the base of the petrous bone, which was fractured transversely near its outer extremity, and more or less separated from all its usual connections; the anterior part of the bone was also splintered off longitudinally." "The ball itself was firmly fixed in the floor of the tympanum, the walls of which were largely destroyed, while its roof was broken into small fragments, so that, when the dura mater was removed, there was a gap in the floor of the middle fossa of the skull nearly half an inch in diameter. On the outer surface of the detached petrous bone, the projecting promontory of the inner ear was discernible. The dura mater was not perforated, but was detached from the injured bone, being separated from it by a mixture of lymph and extravasated blood. There was no blood in the arachnoid cavity." "The tissues at the site of the main lesion had evidently been contused and subsequently inflamed. The inflammation had spread inwards and forwards along the base of the brain, the pia mater being thickened by exudation of lymph into its substance; there was a considerable quantity of serous fluid in the arachnoid at the base of the brain." The bullet was found imbedded in the floor of the tympanum, and "was with difficulty recognized, and some degree of force was necessary to dislodge it." "The cause of death was meningo-cerebritis consequent upon a compound fracture of the skull, attended with bruising of the brain."

Dr. J. O. Green published the following case:[1]

A man, aged 40 years, with suicidal intent fired two shots from a small revolver directly into the right external auditory meatus, the immediate effect being "absolutely negative." The patient, when seen four days afterwards, had some dull pain over the right side of the head, and some tenderness of the right ear and same side of face.

[1] Transactions of the American Otological Society. 1881. P. 471.

There was facial paralysis, but no visible lesion about the external ear. Pulse and temperature normal; no dizziness. "Examination with the speculum and reflected light showed the deeper meatus filled with black masses of half-burnt powder, and with a probe loose foreign bodies could be felt deep in." There was a moderate discharge of discolored serum from the ear. The entrance of the meatus was unusually small. On the sixth day, "a semi-circular incision was made above and behind the auricle, through the periosteum, and the periosteum with the auricle and cartilaginous meatus carried forward till the edge of the osseous meatus was reached; the insertion of the cartilaginous to the osseous passage was then cut through in its upper and posterior part." After turning the auricle forward, an irregular bit of lead was extracted by the forceps, after which the anterior wall of the meatus was removed. Another mass of lead was found impacted deep in, and with considerable difficulty removed. Still another large mass of lead was removed, found firmly fastened in the deepest part of the meatus. The auricle was then replaced, sutures applied and antiseptic dressings. The patient did well until five days after the operation, when he became sullen and refused food. On the sixth day he was attacked with vertiginous symptoms and became delirious. Death occurred on the seventh day. The autopsy showed, among other conditions, a slight greenish discoloration over the petrous bone, due to serum beneath the pia. "Just above the roof of the tympanum, the dura, pia, and brain substances were firmly adherent" to the bone. Above this, a sinus entered the brain, passing upwards for half an inch, "evidently the track of a piece of one bullet." "Small fragments of bone imbedded in the dura at this point." "Pachymeningitis existed over the right convexity." The temporal bone, when examined, showed that "the whole anterior wall of the osseous meatus down to the tympanic ring was wanting; the tissues in front of the ear and around the glenoid fossa were gangrenous. The roof of the tympanum was perforated by an opening eight millimetres long and four millimetres broad; this opening being covered by the inflamed and adherent dura, and corresponding with the bullet track of the brain. The bone within the tympanum was entirely denuded; no trace of any of the ossicles could be found, and the lower edge of the fenestra ovalis was broken away, making a large opening into the vestibule, and the promontory around this opening was black. No trace of any lead was found within the bone."

Terrillon[1] reported a very interesting case where extraction of the ball was followed by recovery:

Patient, a man 28 years of age, had received a shot from a revolver some four months before. The missile appears to have entered the external auditory canal in a slightly oblique and upward direction. Great hemorrhage and pain followed, and severe inflammatory symptoms. These seemed to have passed away in the course of a month, however, leaving the patient perfectly healthy, excepting a purulent

[1] Annales des Mal. de l'oreille et du larynx. Paris, 1878. IV.

discharge from the fistulous opening in the canal where the bullet had entered. There was also complete deafness in this ear. Symptoms of cerebral trouble did not exist. On probing, this ball was found lying about two and a half centimetres from the entrance of the fistulous opening posteriorly and above, and firmly fixed in the bone. All attempts to remove it through the opening failed, and it was finally extracted only after the pavilion of the ear had been dissected free from its attachments to the mastoid bone. The recovery of the patient was a rapid one.

The following case occurred in the author's own practice:

Patient, a male 19 years of age, was shot with a revolver (22 cartridge) in the left ear, March 12th, 1884, by a person standing to the left side and somewhat behind him. He fell to the ground at once from the shock, was slightly confused for a few minutes, but got up and walked without aid, although he felt slightly dizzy. There was some hemorrhage at first from the ear, but this soon ceased. When admitted to the hospital, he was dizzy, had a slight headache, and some tinnitus. He could only hear a watch on contact in the wounded ear. The tragus was slightly abrased, and in it was imbedded a small piece of lead. The drum-head was fractured, and the lower wall of the canal was considerably lacerated. Efforts to find the ball during the next few days failed. Some pain in the ear and a purulent discharge developed. Tinnitus was also present at times. When seen by the writer, eighteen days after the injury, a purplish cyst was found on the superior wall of the meatus, due to burrowing of secretions from the attic (?), which partially occluded the lumen of the canal. The latter was filled with pus. A perforation was seen in the posterior segment of the drum-head. The lower bony wall of the canal, from the tympanum outwards, was much denuded, the lacerated tissues bleeding easily. A Nélaton probe rubbed forcibly over the entire exposed lower wall of the canal, and also as far as possible in the tympanum, came away without any marks of lead. A probe could be passed down between the cartilaginous and bony walls, and somewhat anteriorly, but without encountering the bullet. Movement of the jaw was free. There were no vertiginous symptoms but tinnitus, like escaping steam. Low voice could be heard in the injured ear at ten feet distance. During the patient's stay in the hospital, all attempts to find the ball proved fruitless. He left the hospital in three weeks' time, and was then suffering much from dizziness. During the following eight or nine weeks there was a more or less purulent discharge from the ear, with occasional attacks of pains and dizziness. The canal was much occluded with granulation-tissue, but, by means of local applications, had been much enlarged.

At this time a vulcanite dilator was introduced, by mean
the meatus was much enlarged in three days' time, and
in the osseous portion for a short distance. The
considerably less. The canal finally was fr
view of the drum-head. In the anterior
membrana flaccida there was a perforation

salva, dark colored pus exuded. A perforation in the posterior segment of the membrana vibrans remained.

Nearly six months after the injury had taken place, a dark object was seen lying against the inner wall of the tympanum. It could be easily moved with the probe, but it was impossible to extract it with the curette. After this the patient failed to appear for some six months. His condition was then about the same. Several months later he was finally persuaded to undergo an attempt at extraction, under narcosis. Some small fragments of lead were brought away with the forceps, which were, however, too slight to retain their hold. The bullet was seen through the speculum, being quite movable in the tympanic cavity. The patient was told to return on a subsequent day, at which time suitable forceps had been provided, but he failed to do so.

A review of the cases of gunshot injury occurring in warfare, and of which a number of histories have been given above, will bring to light some very interesting facts.

Mention has been made above of sixteen cases of aural injury from gunshot wounds, which were found in the "Medical and Surgical History." An analysis of this group shows that in two of them only was a discharge from the external auditory canal noted, and in two of them facial paralysis occurred. Of these sixteen cases ten were on the left side, three on the right, and in three the ear affected is not stated. The greater frequency of occurrence on the left side was doubtlessly owing to the fact that the wounded, with two exceptions (a medical officer serving with a battery, and an artilleryman), belonged to the infantry and, when wounded, were engaged in the act of discharging their own muskets, and must have been, therefore, presenting the left side of the head to the enemy.

In twenty-nine cases, where the ear was the seat of direct injury, *by entrance*, it is found that the left side was struck fourteen times, the right in nine cases, whilst in six the ear injured is not mentioned; thus showing the greater frequency here of left sided gunshot wounds to the ear.

In all of these cases the missiles were musket balls, with but one exception, where the injury was caused by a canister shot (see case of Luecke, p. 164). We find furthermore that in these twenty-nine cases, the mastoid was the point of entrance of the missile in twelve, the external auditory canal in five, and the squamous portion of the temporal bone in four cases. The ball entered immediately in front of the external auditory canal in five cases and in the immediate vicinity of the lobe of the ear in three cases.

Besides the two cases of facial paralysis occurring among the sixteen cases of aural injury mentioned in the "Medical and Surgical

History," and to which allusion has just been made, we find that this lesion was one of the results of the gunshot wounds in seven other cases, including those of Guyon, James and Green.

In observing the effects of gunshot wounds of the organ of hearing it will be seen that the *middle ear* may be affected in different ways. A simple rupture of the membrana tympani may take place, or disturbances of its tension, with consequent deafness and tinnitus. The ball may become impacted in the tympanic cavity, after having wounded the external parts of the ear in its passage; if entering from behind the mastoid would be perforated—laterally the external auditory canal and probably the mastoid cells. Missiles (musket balls) coming directly into the middle ear the length of the canal, would very probably produce a fatal result.

The *mastoid process*, it will have been remarked, is very liable to gunshot injury, the missile entering from behind and from the front. When the result is not fatal, obliteration of the cells with permanent external opening and communications with the middle ear (usually the transmitting mechanism is destroyed) will follow.

The *external auditory canal* may be injured by missiles coming from almost all directions. Wounding of the cartilaginous portion may lead to stricture or there may be occlusion of the osseous portion of the canal, owing to deposition of new bony tissue. The missile may lodge in the walls and impinge on the calibre of the canal. The result may thus be the exclusion of sound, the alteration of the tension of the transmitting mechanism, tinnitus and deafness. There is, of course, a danger of subsequent middle-ear inflammation in these cases.

The *auricle* may be carried away by a musket ball or by larger missiles. In the "Medical and Surgical History" seven instances are found where the auricle was cut off by "larger projectiles, either cannon-shot, shell fragments, or grape." In two cases great mutilation of the auricle was produced by musket balls. "Of these nine patients, six were returned to duty, with the sense of hearing believed to be as acute as ever, and as the three who were discharged cannot be traced on the pension rolls, it is probable that their disabilities were not serious." The loss of the auricle may, however, entail defective orientation and imperfect collection of sound, and probable injury to the tension of the conductive mechanism, with consequently more or less deafness and tinnitus aurium. Union may take place with occlusion, if care be not taken in replacing the detached auricle.

SABRE WOUNDS.

The abstracts of incised wounds of the scalp or cranium in the First Section of the Medical and Surgical History of the War of the Rebellion give the history of three hundred and thirty-one cases of this injury. These, it is stated, "comprise all of the sabre or sword cuts of the head entered on the registers of the Surgeon-General's Office, that can be satisfactorily verified. Others are alluded to by medical officers, but so indefinitely, that identification has been impracticable.' Although the temporal region is stated to have been frequently wounded in these cases, the author can find no reference to any injuries of the ear.

The face was injured in thirty-seven instances by sabre cuts and in twenty-seven by bayonet thrusts. The compiler, in regard to wounds of this region, states that "the abstracts of face injuries selected comprise few of the ear. The wounds of the auricle were either infrequent or else regarded as of insufficient importance to be particularized." This the writer can well understand, since he himself saw a considerable number of sabre wounds of the scalp and auricle, which were received in the engagement at Front Royal, Va., May 23d, 1862, where cavalry were actively engaged on both sides. Some of the cases came under his own observation a week later when General McDowell's advance reached Front Royal. Nearly all the wounds seen then had been dressed by bringing the parts together with adhesive plaster, and sometimes with stitches, and were doing so well that no further attention was necessary at that time. Abstracts of none of these cases appear in the published reports, and it seems probable that a very large number of such patients were never reported to the Surgeon-General's Office.

Sabre wounds of the ear were much more frequent in the warfare of ancient times than they have been of late. Ambrose Paré states that the ears are sometimes wholly cut off; sometimes only in part, and again in other cases only slit so that the rent portion still adheres. Since the more general employment of firearms in warfare has been in vogue, however, the frequency of sabre wounds has greatly decreased, although some allusion to such injuries may be found in the writings of Guthrie, Hennen, Larrey and other military surgeons who enjoyed remarkable opportunities for observation during the great European wars in the early part of the present century. Hennen regards sabre wounds of the ear as very simple.

Treatment.—It seems to be the opinion of all writers on this subject that when the ear has been cut off entirely all efforts to restore

it again will be unsuccessful. Paré says that so long as the rent portion adheres to the rest it may be made to re-unite by means of sutures. He strongly advises against passing the needle through the cartilage, however, since gangrene might occur from such a proceeding. After securing the edges of the wound, including only the skin and tissues covering the cartilage, the rest of the cure comprises the employment of pledgets and ligatures carefully adjusted. Special care, however, should be taken, says Paré, that the severed parts be so adapted that in uniting no obstruction of the auditory canal



FIG. 28.

result, interfering with the entrance of sound. A piece of punk is recommended for this purpose, to be introduced into the meatus.

Larrey[1] does not agree with Paré respecting the use of sutures, for he lays down the rule that the cartilages of the ear should be included within the stitches of the suture, since "no unpleasant symptom will result from it, and the suture will only be the more exact and firm." Care should be taken, says Larrey, "to fill up with charpie t[illegible]

[1] Larrey, Baron D. J., Observations on Wounds and their Comp etc. Translated by E. F. Rivinus, M.D. Phila. 1832.

termediate spaces of the sinuosities of the ear and the channel by which it is separated from the temple." The dressing is then to be completed by a retaining bandage, which should not be disturbed until complete cicatrization has taken place.

In operations on the organ, it may furthermore be stated, the auricular cartilage serves the purpose of a splint, and when any bandaging becomes necessary, the surgeon may avail himself of the unyielding surface, over which the pinna is spread, to keep the parts in place.

When the divisions are unequal or jagged, owing to the inequal-



FIG. 29.

ities of the instrument with which the injury has been inflicted, it is necessary to cut the edges of the division smooth before bringing the parts together, otherwise there is apt to be a want of uniformity in the cicatrix.

In regard to the treatment of lacerated and incised wounds of the ear in general, it may be said that surgeons do not now hesitate as formerly to employ sutures in bringing the edges of the cartilage together, and deformities of the organ from injuries, therefore, do not often occur. Even when the auricle has been almost entirely detached from the head, it may be successfully restored. The accompanying cut (Fig. 28), taken from photograph, shows the auricle of

a man, in whom in childhood the organ was nearly severed from its attachments by the injury inflicted by a cart-wheel. The wound was dressed by a person who happened to be present, and did well. The position of the auricle was excellent so far as appearance was concerned (unless viewed from behind, as seen in Fig. 29), but it so happened that the meatus was closed by the cartilage of the concha. It is important, therefore, that the surgeon, in order to obviate such a result, should insert a plug into the external auditory meatus in these cases, thus keeping the canal open until the parts have healed entirely.

The writer saw another case, similar to the one just described, where almost complete detachment of the auricle occurred from the kick of a horse.[1]

ARROW WOUNDS.

Injuries of the ear from arrow wounds are now so rare as to scarcely entitle them to mention here, although in ancient warfare they were probably very frequent. Of the fifteen cases of arrow wounds of the head, face, and neck, reported in Circular No. 3, the author finds two instances where the ear was injured; in one of these cases there was "a slight cut from an arrow in the left ear," and in the other an iron arrow-head lodged in the petrous portion of the right temporal bone. It has been observed that where wounding by arrows has occurred, the patient has generally received multiple wounds from this cause; fatal wounds were thus received in both of the cases mentioned.

[1] Amer. Journal of Otology, Vol. 4, p. 48.

CHAPTER X.

WOUNDS AND INJURIES OF THE DRUM-HEAD AND DRUM OF THE EAR.

These may be limited to the drum-head, but it should be borne in mind that they usually include the drum also, either as a result of simultaneous wounding or subsequent extension of inflammation. Traumatic lesions of the drum-head are caused : (1) by blows upon the ear with the open hand or fist ; (2) by blows with missiles ; (3) by falls upon the ear ; (4) by the violent impact of intense sounds or concussive force, as (*a*) the concussion from the blast of projectiles or great guns, (*b*) from the blast of small arms or small explosives, (*c*) from long-continued musketry fire, rapid firing machine guns, etc., (*d*) the impact of steam whistles, loud voice or of other intense sounds, as metal hammering ; (5) by concussion or penetration of objects thrust into the ear ; (6) by violent entrance of water in syringing the ear and in surf bathing ; (7) by violent traction on the auricle ; (8) by sudden condensation of air in the drum ; (9) by the impact of ceruminal plugs ; (10) by the rarefaction of air external to the drum-head, as in diving and in the compressed air of caissons ; (11) by the introduction of molten metals, scalding fluids, steam or strong acids ; (12) by shot wounds ; (13) by lesion of the drum in fracture of the temporal bone.

I. TRAUMATIC LESIONS OF THE DRUM-HEAD CAUSED BY BLOWS UPON THE EAR WITH THE OPEN HAND OR FIST.

Nearly all blows upon the side of the head may injure the ear, and thus range themselves under this category. The custom of ear-boxing is of long standing ; thus, according to ancient writers, the classical boxer regarded the ear as the most vulnerable part for the infliction of a blow with the deadly cestus. But, later on, early Christianity aimed a blow against this pagan custom, and with unflinching fortitude the non-combatant, when smitten upon one

cheek, meekly presented the other to the still persistent advocate of corporal punishment. And it is due to this kindly example that custom no longer sanctions the practice, though the principle upon which it was founded may have been almost forgotten.

But a great amount of heedless and brutal punishment is still inflicted in this way, not only by pugilists and contestants generally, but also by teachers, parents, and others who find that a punch about the ears is generally a painful and most effectual means of chastisement.

Though corporal punishment, in general, is less in vogue than formerly, the writer has found 51 cases among his records, embracing almost every variety both as regards causation and results, where the ear has been injured by blows of the open hand or fist. Viewed from a clinical standpoint, it was found that 31 of these were males, and 20 were females; of the males, 13 were boxed upon the right ear, 13 upon the left, and 3 of them upon both ears. One was kicked by a companion upon the left ear while bathing, and the right ear of 1 was injured by having the head violently squeezed between the hands of another person. Of the females, 14 were struck upon the left ear, and 6 upon the right. Five of the women were assaulted by pugilistic spouses, which may account for the disproportionate injury to the left ear, since this side is most obnoxious to a right-handed blow.

Though evasive and incorrect answers were often given, inquiries elicited the fact, that of the entire number 8 were boxed in play, 4 by rigorous pedagogues, 2 by parental disciplinarians (the number of these, of course, was actually much greater), and 1, a fervent lover, received a chilling, backhanded slap upon the ear from his indignant sweetheart, effectually cooling his ardor as well as upsetting his equilibrium. The facts in this last case, like many others, only came out long after a misleading statement had been first made.

Several cases occurred among pugilists, the left ear being usually struck in cross-counter. Others were due to assaults, brawls, and contests generally.

The writer, in reflecting on this subject, has been puzzled not a little at the comparatively small number of persons coming to our public clinics with aural trouble produced in the manner under consideration. But when it is considered that but few have any idea of the meaning of the disagreeable symptoms caused by concussion of the ear and its consequences, one need no longer wonder that the injured organ receives no attention. Indeed, it can be readily understood that persons rude and thoughtless enough to box the ears of children will neglect them afterward. Thus but six children came

expressly for treatment for recent ear-boxing, though a large number coming for other affections of the ear could recall having had it slapped or pulled previously, and having had subsequently severe pain, distressing noises, and vertigo—symptoms enough, truly, to subdue unruly children, or even a prize-fighter, for that matter.

One cannot lay too much stress on the social aspect of this subject, since the medical adviser may be entirely misled in respect to the causation. Deafness itself is not usually a noticeable feature in children, especially so long as one ear is fairly useful ; nor is the yet more distressing symptom of autophonia in its various forms. It is only when pain is unendurable, a discharge offensive to others, or instruction difficult, that the conscience-stricken or reticent parent acknowledges the facts on which a correct diagnosis may be made. A striking case in point occurs to the writer. It was that of a youth, eighteen years of age, who was brought to the New York Eye and Ear Infirmary by his mother, on account of an acute purulent inflammation of the middle-ear with suspicious symptoms of intracranial trouble. He gave the history of a discharge from the affected (right) ear ever since it had been boxed when he was six years of age. The present exacerbation was due to the rapid growth and consequent pressure of a large polypus. He was advised to have the tumor removed and place himself under treatment, but being very nervous and timid, he lacked courage to consent to the operation. Getting temporarily better, he failed to return. About a year after this, much more serious vertigo, with other brain symptoms, occurred suddenly, and after a brief illness he died in great agony. The autopsy revealed caries of the petrous bone and pachymeningitis. The father of the boy communicated the final result to the writer, and with much feeling stated that it was he himself who had struck the blow upon the ear which had thus finally resulted in his son's death.

Another case was that of a young man, aged twenty-two, whose father had given him a blow upon the left ear six years previously. Severe inflammation of the middle-ear followed, lasting for two years, during which time the air whistled through a perforation in the drum-head whenever he blew his nose. When seen, the drum-head was found thickened, irregular, and otherwise changed almost beyond recognition. Hearing was very much impaired, and for this relief was sought.

In yet another instance of this kind the patient, a young man aged twenty, was slapped upon the left ear by his father. There was immediate pain and deafness, followed in a few hours by a watery

discharge, which afterward was tinged with blood. When seen at the Infirmary, two days after the boxing, a perforation in the lower segment of the drum-head was giving vent to a free discharge, and the middle-ear inflammation was complicated with periostitis externa-the mastoid cortex being swollen, red, and tender to the touch, Autophonia, noises in the head, and pain occurred at the beginning, and were very distressing for a long time, recovery not taking place for three months.

The grave consequences of pounding the ear were well shown in a case of a woman, addicted to drink, aged thirty-eight, who was struck violently by a man upon the right ear in an altercation. The immediate result was severe dizziness, and she had to hold on to a stair-railing to keep from falling. Vertiginous symptoms became more severe, and the pain and autophonia with this alarmed her very much. She was taken to a dispensary, where an energetic attendant, feeling that something must be done, vigorously inflated the ear by Politzer's method, causing extreme pain in the ear, and afterward introduced some irritating medicament on cotton wool with instructions to keep it in the ear. After this the pain became more severe and she came to the Eye and Ear Infirmary, where the drum-head was examined. This was found to be ruptured. An enormous quantity of serous fluid was escaping from the ear, which was believed to consist largely of the water of the labyrinth, thus indicating that the round window had also been ruptured by the blow. She had now become extremely nervous and experienced insane hallucinations, as was confirmed by the physician, who saw the case. She was admitted to the wards of the Infirmary, and purulent inflammation of the middle-ear soon set in. The cerebral symptoms—pain, vertigo, hallucinations, etc.—became more grave. They seemed due in part to the concussion of the blow; but on reviewing the case the author is convinced that there was also transmission of a septic irritant through the cerebro-spinal fluid into the cranial cavity, inducing leptomeningitis. The patient left the Infirmary, where her presence proved a great inconvenience to others, before she was well, and when last heard from, a month after the injury, had not recovered.

One not uncommon result of a blow or fall on the ear, might as well be mentioned here. A ceruminal plug is sometimes impacted with considerable force against the drum-head in this manner. The contusion causes pain; if the plug lies long in contact with the drum-head inflammation may ensue.

Rupture of the drum-head occurs not so much in consequence of the *force* with which blows are delivered upon the side of the head as

from the violence of aërial compression in the external auditory canal. Blows thus causing sudden concussion may come from above or below the ear, or from the front or rear. Occasionally they fall perpendicularly to the external auditory meatus. In the majority of instances, however, compression takes place through the rapid collapse of the outstanding cartilaginous framework down upon the orifice of the canal. Where the canal is large, condensation is much more effective than where it is very narrow. Pugilists and contestants experience repeated ruptures of the drum-head, and examination of the parts will often show very marked deformities. In two cases observed, the patients exhibited rupture of the drum-head in either ear from blows simultaneously inflicted.

Traumatic injury of the mastoid is said to sometimes rupture the drum-head, but in cases of this kind seen by the writer, while having mastoid contusions, they were, on careful inspection, found to also exhibit evidence of blows upon the auricle at the same time. A very gentle slap, it must be remembered, may, under favorable circumstances, rupture the drum-head, especially in elderly people, in whom it is more friable. Obscure head symptoms, which are often experienced after falls or blows upon the side of the head, so slight that injury of the hearing organ has not been suspected, should therefore suggest an examination of this organ. Boxing the ear, moreover, is known to strain or contuse the drum-head without actual rupture.

Subjective Symptoms.—Violent concussion of the drum of the ear gives rise to more or less disturbance of its tension. Numbness about the ear and certain acoustic phenomena, as autophonia and tinnitus, are experienced. The patient at first is usually also confused or stunned. The degree of consequent vertiginous phenomena corresponds to the concussive force and the damage done, but of the fifty-one cases herein cited, only one was actually felled by the blow, and none were made unconscious.

Nervous shock or cerebral concussion is not so great as would be expected when it is considered with what force the indriven drum-head acts upon the ossicles. The stapes, however, owing to the peculiar construction of the transmitting mechanism, cannot be driven with undue force into the oval window in which its base is fixed, though the concussive force from without entirely destroys the drum-head. In extremely violent concussions, however, the drum-head does not always offer sufficient resistance to the force of impact to protect the round window from rupture ; its excursions under such conditions may at least give rise to labyrinthine concussion. Such cases are, however, extremely rare as a result of a blow of the hand or fist. Or-

dinarily the disturbance of equilibrium is slight and of brief duration. Occasionally it lasts for days or weeks, and more or less dizziness may be experienced for an indefinite period.

Pain is usually an immediate symptom, though not invariably so; it may commence only as reactive inflammation comes on, that is to say, in few hours, or as a result of meddlesome treatment. In intensity it varies from slight discomfort to great suffering. Its duration depends on the extent of contusion, subsequent inflammation, and the nervous temperament of the patient.

Deafness in cases of slight injury may be scarcely perceptible. It is rarely very great at the beginning, and, other symptoms causing more distress, it is liable to be overlooked. It is, for the most part, due to consecutive inflammation of the drum, and therefore need not be considered here. A mere slit in the membrana vibrans scarcely impedes its oscillations in a perceptible degree; nor does contusion of the membrana flaccida. Slight inflammation of the mucous lining of the drum, however, causes greater or less deafness.

Various phenomena, both objective and subjective, attend trauma of the drum of the ear. The sudden and violent tension of the transmitting mechanism gives rise to a sound like the twang of a musical chord, or the sound of a vibrating bell or tuning-fork. Rupture of the drum-head announces itself to the patient with an explosive sound like the rupture of a small bladder or the discharge of a gun. Sometimes the ringing and explosive sounds are both of them heard. Subjective noises supervene, common to middle-ear affections.

Autophonia is a very constant symptom. The resonance of the drum, upon which it partly depends, varies with the degree of swelling and the amount of fluid present. When the ear-drum or other localities in the head reached by the air-passages thus becomes resonant to the voice or other sounds, the confusion, and even alarm, of some patients is very great.

Numbness.—The sensitive nerves of the temporal region are often found in a hyperæsthetic state, the parts giving rise to "tingling" sensations when touched.

Perforation whistle may afford the only intimation of rupture of the drum-head, where a slight blow upon the ear has been given. The escape of air on inflation of the drum, however, is not always of a whistling character, since the quality of the sound depends on the size and shape of the vent in the drum-head and the patulency of the Eustachian tube. Any considerable inflammation of the drum, whereby its lining membrane becomes thickened, thus diminishing its cavity and obstructing the air from the Eustachian tube, or an accu-

mulation of secretions, would affect the character of this sound. The difficult escape of air, or its passage along with fluids, gives rise to peculiar noises, very different from the whistling to be heard several yards away when the drum cavity is dry and the opening happens to be of the proper size.

Objective Symptoms.—The drum-head is at first congested, the injection being greatest in the membrana flaccida, and usually extending down along the malleus handle where the network composing the malleus plexus of vessels becomes prominent. But this clears up again in a few hours, unless inflammation ensues, and slight vascularity only remains in the edges of any wounds produced by the injury.

Multiple ruptures occur, but generally they are single and situated in the lower segment—most frequently in the posterior portion of this. They vary in size and shape; often they are triangular, a flap being left attached at one of the sides of the defect. Some are straight, some semilunar or variously curved.

Course.—Large and irregular rents are not always attended by displacement, but when the edges do not approximate, any loose flap generally sloughs away and leaves an irregular perforation. The edges of perforations, though irregular at first, afterward become more and more smooth as suppuration continues, and the opening may remain permanently. Where there is displacement only, or where the parts are not kept at rest, healing is delayed; but in the more favorable cases it takes place rapidly by primary union. Meddlesome treatment, of course, protracts the case, and if middle-ear inflammation occurs from this or other cause, affairs become complicated. In the greater number of instances spontaneous and complete union may be expected. Suppuration protracts some cases very much, the reproductive process being slow, and opacities, comprising areas of cicatricial tissue of various sizes, remain. If a large area of the drum-head has been lost, a manometric cicatrix often develops itself.

In the 51 cases under discussion the progress was as follows: 7 were unattended with any discharge throughout; 6 had a serous discharge only, and in none of the above were any inflammatory symptoms observed. In 6 cases there was decided inflammation of the drum and swelling of the drum-head, but no discharge. In 25 cases suppurative inflammation of the drum occurred with greater or less severity. In 7 cases the particulars in this regard were not noted.

Prognosis.—This is favorable in most instances; even where there has been suppuration, the drum-head finally heals. The hearing-power is nearly always restored where a mere rupture occurs. Where there

has been suppuration of the drum or other complications, hearing will be more or less impaired. Some of the writer's cases were cured in a few days without remaining injury, while others did not recover for as many months. Several protracted cases were seen where, from neglect or maltreatment, the ear had been discharging for a period of ten years or more. In one case, this condition had existed for thirty-seven years. In these protracted cases a great loss of hearing-power existed.

Diagnosis.—If the ear is examined early enough, or before inflammation has set in, the diagnosis will not be difficult. It is well to bear in mind that the slight traction made upon the cartilage of the external ear, necessary on introducing the speculum, may produce congestion of the drum-head, which is thus made more tense. This congestion is indistinguishable from that caused by boxing or pulling the organ. A perfectly normal drum-head may thus be made to appear to have been injured.

Blood or serum, sometimes both, not infrequently trickle from the ear immediately after the drum-head is ruptured, and when the parts are examined soon afterward, traces of this may be seen. Later on, inspissated clots only are usually visible. Sometimes they are limited to the line of fissure and aid in retaining its edges in contact. Where the contusion has been great, an area of membrane assumes the appearance of a blood-clot, and may slough or remain while reproduction goes on underneath. In some cases the drum-head swells rapidly, all traces of blood-stained fissures and other landmarks being obliterated. In other cases healing is so rapid that nearly all traces disappear in a few days, so that even an expert can discover them with difficulty. When injuries are not seen until swelling has masked the outlines, they will often be found quite distinguishable again after its subsidence.

Ruptures from boxing occur for the most part in the membrana vibrans, while contusions and lacerations from pulling the auricle occur in the membrana flaccida. If not observed for ten days or a fortnight after the injury, the slit-like or ragged-edged wound usually assumes a regular ovoidal shape in cases where suppuration takes place.

A differential diagnosis becomes more difficult when inflammation of the drum, from causes other than traumatic, exists before the injury, or arises subsequently.

The escape of air on inflation of the drum is an infallible sign of perforation of the drum-head; it may be detected with the diagnostic tube when the perforation whistle is not well marked.

The author has never seen adhesion of the drum-head to the inner wall of the tympanum take place as the result of injury from boxing the ear, though this may occur as a consequence of severe inflammatory action.

The appearance of the drum-head a few days after traumatic rupture is sometimes suggestive of *fracture of the malleus handle*, and the first examination is thus often deceptive. In a case of rupture bisecting the drum-head transversely, examined for the first time nine days after the injury, the malleus handle seemed to be fractured at about its middle; but as the swelling subsided it began to appear that no such injury existed.

In comparatively slight swelling, the landmarks become indistinct, or even obliterated altogether; but as healing takes place these are again restored. Suspicions in respect to this injury were not in any instance verified.

Treatment.—It is a safe rule to abstain from doing anything. In most of the protracted cases seen by the writer, there was given a history of meddlesome treatment from the beginning. When intra-tympanal air renewal is active, as shown by oscillatory movements of the drum-head during respiration, the patient should be cautioned against inflating the drum voluntarily. When its presence is borne, a quantity of boracic acid with calendula may be introduced by means of insufflation. This, when no discharge, or scarcely any, exists, quickly forms itself upon the membrane, preventing undue motion. The presence of inspissated sero-sanguinolent effusion upon the outer surface of the drum-head affords protection and should not be removed by syringing. In the more protracted cases where the powder is not borne, the instillation of succus calendulæ proves gently stimulating to the granulating edges of the wound, and, on drying, forms a thin, protecting film of calendulin over the wound. The most simple case may be aggavated by active management, such as inflation, syringing, the instillation of irritants, and the like. Inflammation of the middle-ear thus set up cannot, however, be considered in this connection.

THE MEDICO-LEGAL ASPECT OF BOXING THE EAR.

Claudius, in pouring a "leperous distilment" (juice of hebenon) from a vial "into the porches of his brother's ear," with murderous intent, could not have done the harm that often follows a thoughtless box upon the ear. Thus it has been shown that the functions of this delicate organ may be greatly impaired by a comparatively slight assault.

Redress for assaults of this kind is sometimes sought in the courts

of law. In two cases of recent date coming to the writer's knowledge, the plaintiff was successful in both instances. In one of them, Professor Boyesen, of Columbia College, was sued in the City Court for $5,000 damages.

The suit was brought by a boy through his father, Alfred E. J. Tovey, editor of the *Brewer's Journal*, his guardian *ad litem*, before Judge Hawes and a jury. It was stated that defendant struck the boy, who was then seven years of age, on the head. From the testimony, as reported in the *Times* newspaper of May 6th, 1885, it would seem that the boy received a slap with the hand which did not knock him down. The father testified that his son was not deaf prior to the assault, and that he had since been under medical care. It was suggested by the defence, which contended that only a gentle slap had been given, that the trouble might have arisen from colds, or from having bathed in the sea. A witness testified that the boy went into the water too often, and that he was slightly deaf before the assault.

The jury decided that the defendant must pay $400 damages.

In another case, Marwig *vs.* Davies, large damages were claimed; the case was settled by the defendant consenting to the entry of a judgment. Mr. Newcombe, the plaintiff's counsel in this case, states that the "defendant struck the child—he fell on a rock—producing temporary deafness. Our action was for the assault."

As medical jurists, we must bear in mind that the extent of aural injury, where the patient has been assaulted by a blow upon the side of the head, is not to be measured by the *force* of impact, but rather by the *nature* of the blow. Thus, in one instance the force of a violent assault may expend itself without injury of the hearing organ, while in another a very slight tap upon the temporal region, by suddenly compressing the air in the external auditory canal, may contuse and rupture the drum-head. It has been said already that a simple rupture should be let alone, since in healthy persons it soon heals. It is the purulent inflammation that ensues in catarrhal subjects, or from maltreatment, that causes most of the trouble in these cases. In persons with general catarrh of the upper air tract, traumatic injuries of the ear seem disposed to suppurate. Head catarrh, coming on subsequently to trauma, like injudicious treatment, will generally protract these cases very much.

Where a wound of the drum-head has in this manner become chronic, so to speak, a diagnosis is difficult. Hence, in order to determine the exact degree of injury from traumatism, an expert examination must be made early. Thus, where an examination has been postponed, the rupture no longer presents a slit-like appearance, but

has assumed a more or less ovoidal shape, as has been above stated, and cannot now be distinguished from perforations due to chronic purulent inflammation from causes other than traumatic.

It appears to the writer that the assailant is not the only person to be held accountable for the results of injudicious treatment or neglect; for, although the legal rule, in New York at least, as to liability in actions for damages for injuries to the person arising from tortious acts seems to be, that although the original tort-feasor is ordinarily liable only for such consequences as naturally flow from his wrongful act or negligence, and not for those injuries due to an intervening and intelligent cause, still, if a plaintiff, suffering physical harm from the wrongful act or omission of the defendant, calls in good faith such medical attendance as it is reasonable to presume would be competent to effect his cure or restoration to health, and the physician or surgeon, so called, by erroneous treatment causes positive harm, the plaintiff shall nevertheless recover in the action. At the same time, a jury being the arbiter of the measure of damages, it may be less likely that a large verdict would be recovered against the original tort-feasor in many cases than against the physician, if the latter's malpractice could be established; and the plaintiff, having an action against the medical attendant, who is bound to exercise at least the skill and knowledge possessed by the average practitioner of his neighborhood, may often find him a more desirable defendant, especially if pecuniarily responsible, than the original wrong-doer, although the latter may be also responsible at law.

It is important to ascertain if there has been deafness or a discharge from the ear before or at the time of the alleged injury, and if so, whether any increase of the trouble was caused thereby. This is a point concerning which reliable evidence must, in many cases, be entirely wanting or difficult to obtain, since both may exist without the patient's knowledge. Nor is the testimony of others in this regard always competent, for both teachers and parents, where children are concerned, may have no suspicion of deafness where it actually exists, so long as one ear remains sound, or even fairly so. Where the ears have been pulled and boxed repeatedly, some impairment of the organ of hearing is nearly always found, and often very pronounced in degree. But where the injury has been but slight and confined to the drum-head, with rapid recovery, hearing is usually completely restored. In ascertaining the loss of hearing power, the voice is the best test, for the inability to converse is a greater detriment than not to be able to take cognizance of other sounds. Malingering may be resorted to by the complainant, but unless cleverly done is not liable

to deceive the expert examiner. This, however, is a device seldom practised unless absolute deafness is claimed, a result seldom following boxing of the ears. Where great deafness is claimed to result from trauma, the drum-head should be carefully examined for evidence of resulting deformity, using, if necessary, a magnifying lens.

The question of permanent injury from shock is likely to come up in some cases. Every one knows that falls and blows upon the head often give rise to vertiginous phenomena, but serious labyrinthine concussion as a complication of ear-boxing is comparatively rare, since the concussive force from blows with the hand or fist is broken by the drum-head, thus protecting the round window. Acute inflammation of the middle-ear consequent upon trauma, as from other causes, is very often attended with vertigo. In cases where purulent inflammation of the middle-ear has followed trauma, vertigo, autophonia, and various forms of tinnitus, as well as deafness, may remain permanently. It is well to remember that deafness from chronic catarrh of the middle-ear is much more likely to be found on the left side.

2. INJURIES TO THE DRUM-HEAD FROM BLOWS UPON THE EAR WITH MISSILES.

Wounds and injuries from this source are similar to those produced by boxing the ear. They may be due to the impact of balls, stones and other objects, or to swinging doors and gates, chains and the like, striking the ear.

Of this group there were 14 males and 2 females. Four were between 3 and 18 years of age; three between 20 and 30 years of age; four between 30 and 40 years of age; four between 40 and 50 years of age, and one was 53 years old. The left ear was affected in twelve cases, the right in three cases.

Five were injured by *snow-balls;* in one instance the ball was frozen solid; in one it was wet and hard, and in three of them the snow was soft and part of it became impacted in the concha and meatus.

When the external auditory canals were large, the injury to the drum-head was greatest.

In one case, the ear had been injured 25 years, in one case 17 years, in one 4 years, in two cases eleven days, and in one seven days before they applied for treatment.

The results of the injuries were similar to those arising from boxing the ear. Pain was usually experienced immediately or soon after the

accident. In two instances it was severe for more than a week. In one case there was inflammation over the mastoid extending down the neck, an abscess finally forming behind the auricle. Tinnitus and dizziness were present in some degree in nearly all of the cases. One patient, struck with a snow-ball on the ear some seventeen years before, immediately experienced a sound like a steamboat whistle which lasted for fifteen minutes; there was no pain, but the noise like escaping steam remained. Examination showed a large opening in the drum-head which seemed disposed to become permanent. This perforation was triangular in shape and situated in the posterior segment; through it the dry inner wall of the drum could be seen. There was, furthermore, a small blood-clot in front of the umbo. The man was a pianoforte-tuner, and these symptoms interfered very much with the performance of his duties. A disagreeable perforation whistle remained for some time.

In some of these cases the deafness remaining in the injured ear was very great.

Three patients were struck by *balls* of various kinds. One of them was walking along the street when struck upon the left ear by a base-ball. He immediately became dizzy and a "hissing" noise remained in the ear. There was no deafness or discharge, but in twenty-four hours a perforation whistle was noticed. Examination showed a large, irregularly quadrilateral opening in the anterior segment of the drum-head.

The second case was that of a boy who was struck upon the left ear, while trying to catch a very hard baseball coming from the bat. He reeled over, and for several days the ear pained him very much. He also thinks it discharged a little. It has "buzzed" for the past year—in fact, ever since the accident. Some deafness is present and also considerable hyperæmia, the latter due to the entrance of water into the ear while bathing recently in the sea.

The third patient had been struck on the right ear by a large rubber ball a week before. Pain was immediately felt and throbbing and buzzing have existed ever since. There is a large perforation below the umbo, across the upper segment of which a band of organized tissue has formed; the lower portion of the opening is occupied by a blood-clot. Restoration having thus begun, the opening in all probability closed soon afterwards.

One patient, aged 22 years, was struck on the left ear with a stone nine years before. This accident was followed by a discharge from the ear, and four years later a polypus came away. One week ago, the ear became acutely inflamed, the process extending to the mastoid

and down to the tissues of the neck. A polypus is now seen presenting at the orifice of the canal.

Another patient, an Italian laborer, engaged in blasting rock for a railroad track, was struck on the left side of the head by a fragment of rock, which ruptured the drum-head and nearly detached the auricle. A most persistent discharge remained.

A man, 50 years old, was struck upon the left ear with the fragment of a broom-handle thrown by a boy. The auricle was slightly contused, and for eight days there was very distressing tinnitus. The temporal region remained sore for several weeks. These symptoms were due to the impaction of a mass of cerumen by the blow upon the ear.

Another patient came with the statement that two weeks before, while supporting one end of a heavy telegraph pole, the other end was unexpectedly dropped from the shoulder of his companion. This caused the end of the pole he was holding to strike against his right mastoid process. He was stunned and dizzy for a few minutes, and for three days the whole mastoid region was much swollen. There was immediate tinnitus like "escaping steam" in the right ear, which still continues. Two days after the injury, severe pain was experienced for a couple of hours below the lobe. Examination showed slight hyperæmia of the drum-head. He heard loud voice only. This patient came to the New York Eye and Ear Infirmary, and was seen but once.

The following injury to the ear occurred to a patient who was riding a stumbling horse, when the animal fell upon his knees, throwing the rider over his head. In his struggles to regain his feet, the horse stepped upon the patient's left ear. There was immediate pain, followed in a few days by a "buzzing" noise and throbbing in the ear. Ten days after the injury, which happened two weeks before the case was seen, the patient put cottonwool saturated with "St. Anthony's Liniment" in the meatus and thinks some of it entered deeper into the ear. The ear began to discharge pus the day before he came for treatment. Hears loud voice only in the affected ear. He was seen but once.

In the two following cases, the patients were struck by swinging objects. One of them was struck three days ago on the left ear by an office gate. In a few hours severe pain set in in the affected ear and still exists. Soon after the injury acute purulent inflammation of the middle ear developed. The ear had been syringed, and camphorated oil introduced before he came for treatment, and these procedures seemed to have aggravated the case. The other case was that of a

man who was struck in front of the left ear by a swinging iron bar twelve days before. He was stunned, but kept on with his work. There exists now a purulent discharge and some tinnitus, but deafness is slight.

3. INJURIES OF THE DRUM-HEAD FROM FALLS UPON THE EAR.

The drum-head may be injured by falls upon the organ—the effects being similar to those produced by blows with the hand, etc. In falls upon the head from a great height, fracture of the temporal bone is to be suspected. The latter seldom or never occurs without fracture of the other portions of the base of the skull. The impact in falls is liable to be expended upon the mastoid in some cases with much more force than from blows with the hand. In children receiving falls upon the head involving the ear, it is sometimes difficult, or even impossible, to distinguish between fracture of the base of the skull involving the temporal bone, and traumatic meningitis.

The writer has the records of thirty cases of injuries of the ear in consequence of falls—17 males and 13 females.

Ten of them at the time of the injury were children between 2 and 6 years of age, inclusive; three between 9 and 15 years old; nine between 20 and 40, and eight between 41 and 59 years of age.

The right ear was affected in 15 cases, the left in 11 cases; in 1 case both ears were affected, and in 3 cases the ear affected is not given.

A large number of persons come to the otologist with the statement that some affection of the hearing organ is due to a fall upon the ear. Whilst in by far the greater number of these the trouble can be traced to other causes, it cannot be doubted that to trauma may be attributed the causation in many.

In 11 of the cases under consideration, the injury was caused by falling down upon the earth; 3 fell down upon the ground while in a fainting condition; 3 fell down-stairs; 1 fell down from the second story of a house; 1 fell down a hatchway on board ship; 1 fell from a ladder; 1 fell from a tilting plank; 1 fell from a chair; 1 fell upon the water in diving from a height; 3 slipped and fell upon the ice; 1 was thrown from a wagon; and 3 struck the ear against resisting objects.

Of the 11 receiving injuries from falls to the earth, 8 were children between 2 and 9 years of age, the rest being adults. The accidents occurred for the most part in New York City, the falls taking place

upon the hard sidewalks, curbstones, or pavements. In one case, the child was "stupid and drowsy" after the accident, and had a serous discharge from the ear (probably a case of fracture of the temporal bone). In another case, the patient, a child four years of age, fell upon the sidewalk while running, and three days afterwards there was fever, and the "head was affected." The child was confined to its bed for a month. One night hearing in both ears was lost suddenly, but during the following three months it returned. This was probably a case of traumatic meningitis.

In one case, the patient fell down upon the chin, the aural injury occurring in consequence of concussion imparted to the temporo-maxillary articulation.

One child, two years of age, fell upon a curbstone, had immediate pain in the ear, dizziness, and some discharge of blood. Several weeks of vigorous syringing and medication, before coming for advice, were followed by a chronic purulent inflammation of the middle-ear and the development of a polypoid growth. The inflammation extended finally to the mastoid region.

From maltreatment or neglect a chronic purulent process of the middle-ear was established in several cases. Permanent deafness occurred in a number of instances.

Of the three cases where falls were due to fainting attacks, one struck the tragus of the auricle on the corner of a table. She was dizzy on rising. Inflammation of the external auditory canal and middle-ear ensued; tenderness and swelling extended down the neck. There was "throbbing" and deafness. Another woman, after severe vomiting, fell to the floor insensible. On regaining consciousness, the right ear was found painful, for which "carbolic wash" was prescribed. This probably aggravated the case, since inflammation of the middle ear and mastoid cellules developed; there was tinnitus and a discharge.

The third case was that of a boy sixteen years of age, who fainted and fell down after cutting his finger. He was unconscious for two hours. The ear bled at the time, and a watery discharge was soon established. The drum-head was fleshy-looking, and perforated in the posterior inferior quadrant. There was pain, tinnitus, and deafness. A free purulent discharge followed, which ceased in seven months, though the tinnitus continued.

Three patients fell down the distance of one flight of stairs. One of them when first seen, a month after the accident, was still troubled with pains, giddiness, and noises in the head. Dizziness was greatest in the morning, when for a time he could not stand upon his feet.

Another, seen a week after the injury, in falling, struck upon the left side of his head. Blood immediately flowed from the left ear, but ceased on the second day, when he experienced pain and tinnitus. There was no deafness.

The third patient was seen one week after the injury. He had been unconscious for some time after the fall. Blood gushed from the right ear, and the next morning the external auditory canal was filled with a blood-clot. There was no pain unless traction was made on the auricle. There was great deafness. The drum-head was so much inflamed that the landmarks could not be recognized.

One patient fell down, six months ago, from the second floor of a house, striking upon the right side of the head; was unconscious for several hours. There was some hemorrhage from the right external auditory canal. Deafness was not observed until a month after the accident. The child is otherwise well.

A patient, while at sea, twenty years ago, fell a distance of sixteen feet down a hatchway. Bleeding immediately took place from the left ear, and he was insensible for three days. Deafness and tinnitus have existed ever since. The canal contains exudative matter. There was probably a fracture of the temporal bone.

One patient, seven months ago, fell a distance of four feet from a ladder, striking against the right ear. There was immediate tinnitus, like escaping steam, which has since become gradually worse. The drum-head is still congested in the anterior segment, the probable seat of rupture. Deafness was not great.

Another patient, three weeks ago, fell ten feet from a tilting plank, striking on the right side of the head; was dazed, and everything "went round." Ever since then he staggers like a drunken man. Has tinnitus. Hears shouting only, and this gives rise to pain. The drum-head had healed when seen, and during the two months the patient remained under observation his hearing improved. These symptoms may have been due to concussion only.

A little girl, aged 3 years, fell from a chair ten days ago, striking the left side of the head upon the floor; she was not unconscious, but blood flowed from the left ear for an hour. There was but little pain or deafness. In the posterior segment of the drum-head, a small red area marks the seat of rupture.

Another patient, a man 26 years of age, gives a very interesting history. At the age of 10 years he "took a header" off a dock ten feet above the water, injuring the left ear. Fourteen years after this, the same ear was injured by the impact of a heavy wave while he was bathing in the surf at Coney Island. Six months ago, when about to

take a plunge from a platform four feet high, he slipped and fell, striking upon the water with the right ear. He was very dizzy on coming to the surface of the water and for a minute could see nothing. He experienced noises and pains in the ear for several days before recovery. There is but little deafness. The external auditory canals are very large. Both drum-heads are perforated.

The three patients who slipped and fell upon the ice were all adults. One came five months after the injury. While skating he fell upon the back of the head and was stunned. Tinnitus was at once remarked, and vertigo and deafness still exist. The left drum-head was ruptured. The other two cases were females; one of them fell heavily two weeks ago, striking the ice with the left ear. Autophonia has been very distressing ever since. The drum-head is ruptured across horizontally, the line of fracture extending under the umbo, giving the appearance of a fracture of the lower end of the malleus handle. The other female had fallen five weeks before, striking upon the back of her head. Was not unconscious, but had to be carried home. There was marked vertigo and complete deafness to voice for two days. These symptoms gradually passed off in two weeks, though some deafness remained. Owing to the injury of the left drum-head, a "rattling" noise is experienced in talking and singing.

A patient, 40 years of age, was thrown from a wagon seven years ago, striking the earth with the left side of the head. There was immediate pain, and numbness and tinnitus have continued ever since. The drum-head was ruptured, a minute perforation remaining.

Of the three patients striking the ear against resisting objects, one fell against a safe, rupturing the drum-head. The discharge which followed lasted for three months, and deafness of the right ear remains. One struck the right ear against the key of a door, causing a discharge of blood, followed by a purulent discharge, at various times, for the past two years. There is occasional pain in the ear and great deafness. The third patient, on getting out of bed in the dark, sixteen months ago, struck the right ear against a shelf. He was unconscious for a time and afterwards felt dizzy for an hour. The middle-ear was much inflamed, the inflammation extending to the external auditory canal and mastoid process. The pains were severe for a month (for a part of this time he was unable to leave the house), and then there was a discharge. The latter, together with some tinnitus aurium, still exists.

It appears that unconsciousness, shock or concussion, vertigo and purulent inflammation of the middle-ear are much more common occurrences after falls than after injuries arising from blows of the

hand, and furthermore that some doubt must exist in many cases in respect to the extent of injury of the temporal bone—in fact it would seem probable that the latter is fractured more frequently than is generally supposed.

4. INJURIES TO THE DRUM-HEAD FROM THE VIOLENT IMPACT OF INTENSE SOUNDS OR CONCUSSIVE FORCE.

A. THE CONCUSSION FROM THE BLAST OF PROJECTILES OR GREAT GUNS.

That the ear may be injured by the violence of aërial impact, or concussive force, propagated by the explosion of gunpowder, has been known ever since the introduction of explosives in military warfare. Owing, however, to the obscurity of traumatic lesions of the drum of the ear, or of its deeper parts, and the limited means of observation at the command of the military surgeon in the field, it has been more difficult to study these injuries than most other wounds. Such was the writer's own experience at least, and reference to the literature of the subject shows that the opportunities of writers on military surgery were probably no greater in this respect. It is a fact, moreover, that from the suffering occasioned by other and more painful wounds simultaneously received, together with the bewilderment caused by nervous shock, aural injuries are liable to be entirely overlooked. Indeed, in some of the cases about to be described, there were serious wounds of the ear of which the wounded men themselves had been unconscious up to the time of examination, several weeks after the accident. It may be stated here, on the contrary, that after artillery engagements it is not unusual for participants to fancy that deafness, due to other causes wholly, has been produced by the loud sounds of great guns, and since the war of the rebellion applicants for pensions not infrequently present their cases with the statement that aural disability has originated in this manner.

While the writer was recently seeking information from persons having had experience in the field or on shipboard, especially among army and navy officers, an opportunity quite unexpectedly presented itself to investigate thoroughly the effects of concussive force on the ears of a number of men, in the midst of whom a twelve-inch mortar shell, weighing five hundred and eighty-five pounds, and containing a bursting charge of twenty-seven pounds of rifle-powder, was acci-

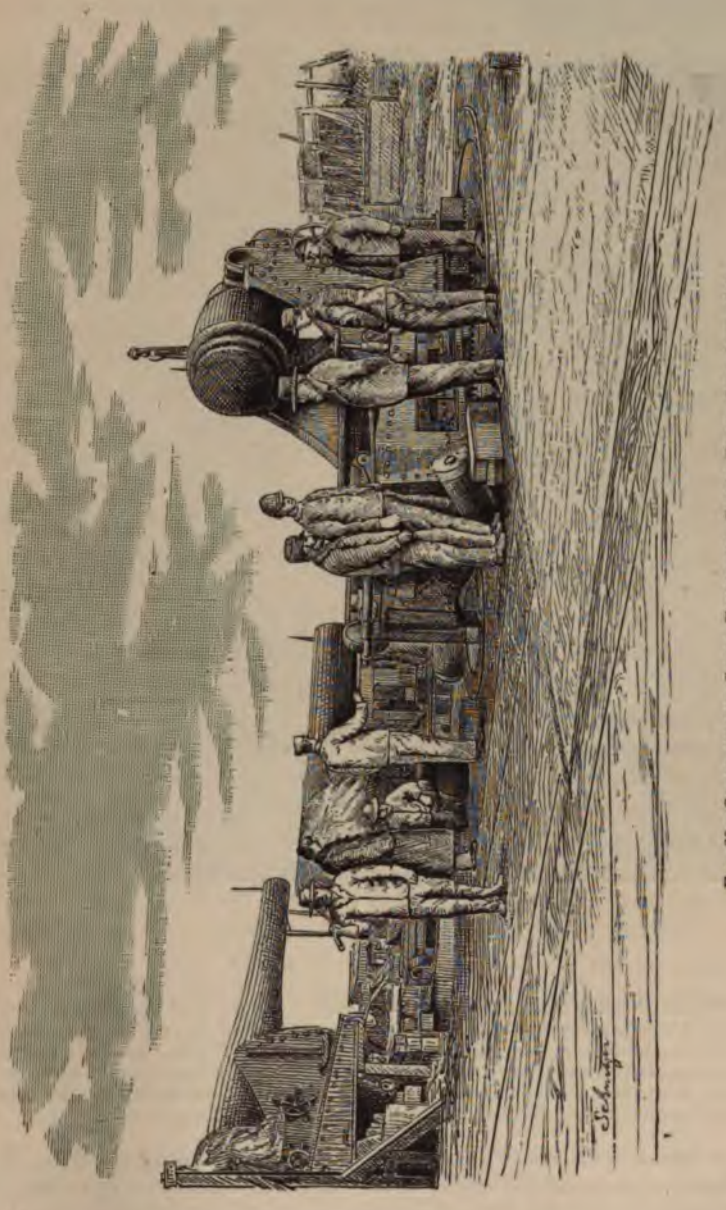


FIG. 30.—SCENE OF THE SHELL EXPLOSION, SANDY HOOK, OCT. 21ST, 1886.

dentally exploded. This took place at the United State Ordnance Proving Ground, Sandy Hook, October 21st, 1886, at 3:30 P.M.[1]

The effects produced by the bursting of this shell, both as regards

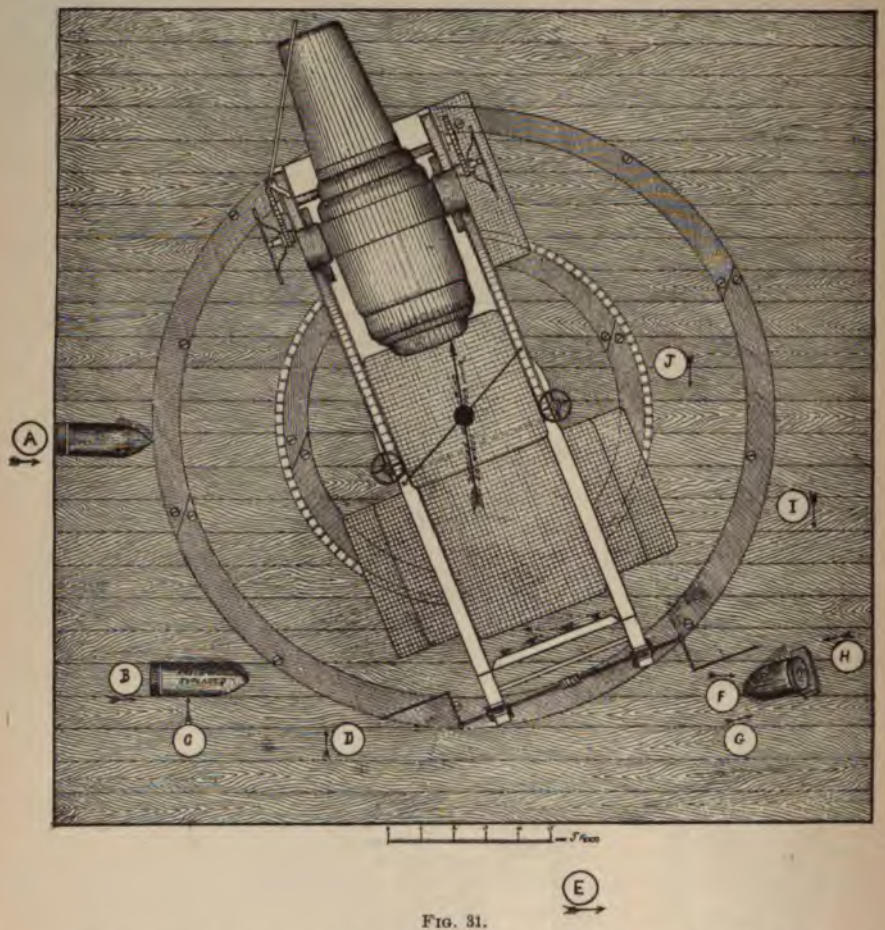


FIG. 31.

A, Sergeant Abbott, position eight feet from the shell; *B*, Private King, position at the base of the shell; *C*, Lieutenant Medcalfe, position at the side of the shell; *D*, Corporal Clark, position four feet from the shell; *E*, Corporal Goodno, position twelve feet from the shell; *F*, Private Cunningham, position fifteen feet from the shell; *G*, Private Cramer, position fifteen feet from the shell; *H*, Mr. Sinclair, position nineteen feet from the shell; *I*, Private Burns, position nineteen feet from the shell; *J*, Corporal Ingram, position sixteen feet from the shell.

[1] The ordnance officers on duty at the time, namely Colonel Mordecai, Captain Shaler, and Captain Whipple, kindly offered the writer every facility for investigation, as did also Colonel Janeway, of the Medical Department, U. S. A., Post Surgeon, Governor's Island.

the aërial concussion of the blast and the distribution of fragments of metal, were, of course, similar to those produced by the explosion of projectiles fired from great guns during an engagement; and, it is hoped, since a careful study of wounds of the ear arising from this cause have never been reported, so far as known, that a detailed account of the conditions of the organ of hearing, found to exist in the persons injured, may be of interest to both medical and military men.

The scene of the catastrophe, as shown in the accompanying cut (Fig. 30), was produced from a photographic view taken on the spot by a friend of the author. The men were taken in about the same position they occupied at the time of the accident; the places of three of them, namely, Lieutenant Medcalfe and Private King, killed, and Corporal Goodno, absent in hospital, were occupied by other persons.

The diagram of the twelve-inch mortar, gun carriage, and platform (Fig. 31), where the firing was taking place, was designed by Captain Whipple; the facings of the men are designated by arrows, and the direction and force of the wind at the time is also shown. The distance of the men from the shell which exploded will, furthermore, be found in the text accompanying the cut.

As an immediate effect of the explosion, Sergeant Abbott was blown ten feet from his position. Private King (who was closing the screw plug in the base of the shell with a drift and hammer, and thus exploded it) was instantly killed, and his body was blown fifty-five feet away; Lieutenant Medcalfe, who was standing by the side of the shell, was blown twenty-two feet and died in thirty minutes; private Clark was blown fifteen feet. The other six men kept their feet during the explosion. Eight men thus escaped with their lives, but all of them were more or less injured by the concussion, and some of them received contused wounds or were burned by the blast.

The three men first described below were examined at the Post Hospital, Governor's Island, October 31st, where they had been sent for treatment. They were still suffering from shock and contusions, but able to walk without assistance to the office where the examinations were made.

CASE 1.—Sergeant John Abbott, aged 34, was kneeling on right knee and toe when explosion occurred, presenting right ear toward the shell. He was thrown ten feet by the force of the concussion, found himself upon all fours, but got up immediately and ran some thirty feet before looking to see what had happened. Noticed that the right side of chest, shoulder, and face were burned by the blast. As regards his hearing, although there was much talking and shouting, he could hear nothing at first. He was much confused, but had

no vertigo or pain in the ears. An hour after the accident, however, the deafness was found to be confined to the right ear. After going to bed, blood was observed on the pillow, and continued to trickle from the right ear for two or three hours, when it ceased. He slept but little. Pain has been experienced in the injured ear on blowing the nose, or swallowing only.

Examination of ears.—Auricles and canals healthy; the latter small.

Right drum-head: A large, irregularly ovoidal perforation of the drum-head exists in the posterior segment; it is bounded anteriorly by the malleus handle, inferiorly by the annulus tendinosus, and above by the membrana flaccida. There is a narrow margin of the membrane between the perforation and posterior wall of the external auditory canal. (This opening was temporarily occupied by a dark crust, probably of inspissated muco-sanguinolent matter.) The anterior segment is dull and fleshy-looking (cicatricial?); the membrana flaccida is considerably injected. The short process is just visible, pressing out as a lighter point in the drum-head.

Left drum-head: Slightly atrophic, moist-looking, and opaque. Short process rather prominent, but other landmarks somewhat faint.



FIG. 32.—ABBOTT: RIGHT DRUM-HEAD.

Hearing: right ear, ordinary voice only; left ear, low voice if plainly spoken—distance, eleven feet.

Patient has some autophonous phenomena, the voice seems lisping, and for three or four days past there has been tinnitus aurium resembling the sounds heard in a shell when placed to the ear. Vision unaffected.

November 27th.—Right ear: The upper portion of the anterior segment is now opaque, slightly vascular, and has a cicatricial appearance; the lower portion is partly cicatricial, exposing some fibrous structure extending perpendicularly. A large, dark, partially inspissated blood-clot yet remains on the lower portion of posterior segment, extending upward in front of the malleus handle; reproduction of the membrane is probably taking place beneath this clot. The clot not shown in diagram. Patient hears low voice at fifteen feet plainly in both ears, but when several persons are conversing he cannot follow them. His voice still sounds to him as if he were lisping. Has occasional tinnitus.[1]

[1] Abbott was not again seen until February 6th, 1888, when he came to the writer's office. He was then complaining of having had pains in the left ear off and on ever since the accident, but especially during the past four months. Five weeks before he had been in the Post Hospital for four days with the earache. Says he feels the pain in the ear especially in damp weather. On

CASE 2.—George Clark, aged 27; entered Governor's Island Hospital October 23d. Was standing, when the explosion took place, four feet from the point of the shell, looking at King, and having the left ear toward the missile. He was thrown fifteen feet, but jumped up at once. Was much confused with a "dumb feeling" in the ears; first running away from the scene, and then returning. He staggered to the pump, some three feet distant, and felt better after he had taken some water. He has been, however, unsteady in his gait ever since, and is very nervous and giddy. He was employed in running errands nearly all night. Afterward was too nervous to sleep. He could not sleep on the second night, but on the third night was given bromide of potassium, which has been continued ever since.

Examination of ears.—Right ear: The posterior segment of the drum-head rather opaque and there is at about the centre a slightly injected spot. The anterior segment is fairly brilliant, with good cone of light. A dark line extends along the posterior edge of malleus handle, having the appearance of a light-brown crust. This might be taken for a shadow, but for the wrinkled appearance of the membrane about its centre, the folds running principally up and down. Syringing the right ear, which has been tried once, gives rise to unbearable pains in the right eye.

Left ear: There is a large loss of substance of the drum-head, em-



FIG. 33.—CLARK: LEFT DRUM-HEAD.

bracing most of the posterior segment below the membrana flaccida, extending inferiorly to the tympanic ring, then curving into the lower portion of anterior segment, and through which the inner wall of the tympanum can be seen. The landmarks afforded by the malleus handle are not visible, but the whole membrana flaccida and the upper portion of the anterior segment of the membrana vibrans has a thickened, macerated, and retracted look. There is a pulsating bubble,

examination, the left lower second molar is found to be in a very carious state, the pulp being probably exposed. The left upper six-year molar is denuded on the palatal surface. Patient never complains of toothache. Examination of the *right* (injured) drum-head shows the anterior segment to be lustreless, and very irregular in front of the umbo; scattered light spot. The posterior segment is also lustreless. The fibrous layer is more or less exposed. The condition of the *left* drum-head has not changed from that already described above.

Patient says his hearing is not as good as formerly, and has become considerably worse during the past four months. He cannot hear the word of command in firing, and relies on others for a signal, in pulling the lanyard. On examination, ordinary voice is heard in both ears at eleven feet distance. The general health of the patient is excellent, but he is worried about his hearing.

affording a light-reflex in the anterior-inferior portion of the tympanum, and another posteriorly.

Hearing: Right ear, low voice; left ear, only low voice at eleven feet distance.

A small amount of blood trickled from left ear the night of the injury; there is now discharge of muco-purulent matter. Pain has been experienced in the left temporo-maxillary space. The ear has been syringed several times daily with a pump-syringe, and the mastoid process was blistered three days ago. For twenty-four hours after the injury mastication was painful. Eructations also gave rise to pain. His own voice is autophonous, and sounds "far off" to him. Patient has become highly neuropathic, and says he has "gone all to pieces." He can scarcely stand to-day, and seems to be getting weaker. Complains also of left eye; says it is "blurred." Both pupils are large, but respond to light. There is twitching at the inner canthus of the left eye and above the angle of the jaw.

Patient complains of pain through temples, with throbbing sensation. His pulse is weak and irregular. There is a noise in the left ear resembling that of a "steamboat."

November 21st.—He has been on duty at Sandy Hook for past ten days. His left arm and leg feel numb unless he is exercising, and especially at night. He is feeling somewhat stronger. Complains of no vertigo, but of much dull pain in temporal regions, which is increased by the firing of great guns. Cold air causes pains in the ears, especially in the left, and patient thinks that the left auricle is colder than the right. The right ear is, however, healthy. The left ear has healed, and the inflammation and discharge have ceased. The perforation remaining is as large as when first seen, and shows no tendency toward closing. The malleus handle is scarcely distinguishable. There is pain, at times, in the ear, but no tinnitus. He has still, however, tinnitus, resembling escaping steam, in the right ear. Introduction of a speculum into the left ear causes tears to flow from left eye, which also feels irritated. When patient uses his eyes in reading, etc., the left gets "blurred," he says, and "weak."

Hearing: Left ear, loud voice only; right ear, low voice, at eleven feet distance.

Patient becomes confused when several persons are conversing.

November 27th.—Patient is now improving, and feels stronger. He is less nervous also. In the left ear the parts are clearing up, but the perforation is unchanged.[1]

CASE 3.—Corporal Walter Goodno, aged 34, had just picked up a handspike, and walked away from the shell. Thought a keg of powder on his right had exploded, and tried to get away. His ankle was hit, hat torn to pieces, and he received a contused wound of the

[1] Captain Whipple writes, December 22d, 1886: "I am sorry to say that I hear Corporal Clark, whom I had transferred back to Springfield, is not doing well. His 'hearing' is getting worse, and he seems to have lost his grip." Subsequently, however, Clark became much better.

scalp, just below the occipital protuberance. Patient had his left ear turned nearly toward the shell at the time of its explosion. He had autophonia at once, could hardly hear his own voice; but could distinguish pretty well what others were saying, in the right ear. Immediately after the injury there was a great ringing in the left ear. Patient says he felt something (which he fancies was blood) drop down "into the throat from the head" about an hour afterward.

Examination of Ears.—Left ear: At the inner end of the canal the cutis is dry, white, and exfoliating. being covered with a light coat-



FIG. 34.—GOODNO: LEFT DRUM-HEAD.

ing of boracic acid and iodoform in powder. Almost the entire portion of the drum-head, constituting the membrana vibrans, appears more or less disorganized; the posterior portion is missing, leaving a ragged edge, and the anterior portion has a bruised, fleshy look. The malleus handle is very prominent.

Right ear: Slight injection along malleus handle. A large circular area, occupying almost the entire upper portion of the posterior segment, is of recent cicatricial formation, with uneven, depressed, and lustreless surface. Behind this can be seen the inferior portion of the long process of the incus. On the umbo is a small, dark blood-clot. Two parallel folds of the membrane, resembling cords, run from the umbo forward and downward to the margin of the drum-head. The area between these is occupied by disorganized substance. Both external auditory canals are large.

Hearing: Right ear, low voice, if plain; left ear, ordinary voice, if plain, at twelve feet distance. Patient still has autophonia. The pulse is feeble, and rather frequent.



FIG. 35.—GOODNO: RIGHT DRUM-HEAD.

December 6th.—Patient has recovered, and will report for duty. *The right ear* shows a minute, dark, and depressed cicatrix at umbo. Below this, occupying nearly the entire area of the lower segment of the drum-head, is a large, circular perforation (see Fig. 35), where there was broken-down tissue before. No inflammatory symptoms remain, and the drum is cured. In the left ear nearly all of the drum-head is absent, and the denuded malleus handle hangs down in front

of the inner wall of the tympanum *in situ*.[1] The anterior edge of the round window and the incudo-stapedial joint is exposed to view. All the parts have a whitish, dry appearance. All discharge from the ears has eased. Syringing or probing the left ear causes a sensitive impression in the left eye and lower part of the larynx.

Hearing: Left ear, ordinary voice; right ear, lowest voice, at fifteen feet distance. Watch heard in left ear only on contact; in right, at thirty-three inches. The extent of sloughing in the membranes in this case is remarkable. The great amount of hearing for the voice is also notable, and quite in contrast to the poor hearing-power for the watch.[2]

The following persons were examined at Sandy Hook, November 27th, 1886, over five weeks after the accident:

CASE 4.—Mr. Allen G. Sinclair, machinist, aged 62 years; has been in the employment of the United States Government for some thirty-seven years, twenty-four of which have been passed in the Ordnance Department. He has been testing guns for twenty years, but has never experienced unpleasant sensations or injury of the ears from this occupation. At the time of the explosion, the patient was standing about nineteen feet from the point of the shell, and facing it. At first he was dazed for some moments, but does not think he was thrown down. His hat was blown off. He had no pain in the ears, but a noise in both resembling escaping steam. This still continues, but is less severe. Of late he has felt pulsations in the ears, mostly in the left. These are variable, scarcely ever occurring before about 3 o'clock A.M., when he fancies they wake him up. His ears have felt "dumb" from the first, at times, and his own voice is autophonous and seems distant to him. No vertigo.

Examination of ears.—Right ear: The malleus handle has a light



FIG. 36.—SINCLAIR: RIGHT DRUM-HEAD.

brown appearance, and behind it lie some inspissated blood-crusts. A cicatricial area extends from the anterior superior border of the tympanic ring downward, and terminates in a transverse band of thicker tissue below. Underneath this band there is a large loss of substance in the membrane, and under this, below the umbo, extend-

[1] The diagrams of the drum-heads in this case, as in the others, represent the appearance of the parts when last seen.

[2] Corporal Goodno suffered a relapse in respect to the wound at the occiput, which had healed but slowly, and on return to the hospital a small fragment of shell was removed from the wound. After this recovery was rapid. This patient was heard from in December, 1887, and was then reported as perfectly well and strong.

ing into the lower portion of the posterior segment, is another area of cicatricial tissue, due to reproductive growth. The denuded short process marks the termination, posteriorly, of the band above mentioned.

A small crust, consisting of epithelium and inspissated blood, which has worked off from the wound of the drum-head, lies on the posterior wall of canal. The parts have healed up entirely, and are free of any injection. Through the large perforation the inner wall of the tympanum is visible.

Left ear: A blood-clot occupies most of the posterior segment of the drum-head, which is elsewhere fairly brilliant. At the junction of the inner end of canal and posterior edge of the membrane, and behind the clot, there is a small ulcerous surface covered with a rather loosely attached scab, the seat of a perforation probably. Both of the external auditory canals and drum-heads are large, and this may account for the great amount of injury. The ears have received no treatment.

Hearing: Left ear, ordinary voice only, at ten feet; not as clearly in the right.

December 13th.—Right ear: The crust of epithelium and inspissated blood, which was described as working off the drum-head on to the posterior wall of canal, can be picked off. The small blood-clot behind the short process has become detached, leaving a reproduced dermic layer beneath. The perforation has become smaller, and its circumference looks as if it would contract still further.

Left ear: Membrana tympani cleared up entirely. The crust on the drum-head, near the wall of canal, has worked off on the canal, and can be easily removed. The blood-clot, which occupied almost the entire posterior segment of the drum-head, is loose, and can be easily removed with the forceps. Beneath this crust, doubtless the seat of a perforation, the membrane has healed up entirely.

Hearing: Left ear, low voice; right ear, loud voice, at fifteen feet distant. Watch pressed against the ears not heard at all. Patient hears the noises in the streets of wagons, etc., like a low, rumbling, unaccustomed sound. He has no nausea, vertigo, etc., and feels very healthy and strong.[1]

CASE 5.—Private Michael D. Burns, 24 years of age, was standing about eighteen feet away, and was dumfounded by the explosion, felt stunned and dizzy, and had "buzzing" noise in both ears.

Examination of ears.—Both canals are of medium size.

[1] Sinclair was seen at the writer's office in December, 1887. He was then feeling well and strong, but said that cold weather affected him more than formerly. The perforation in right drum-head has healed, but the area of thin tissue, as shown in the illustration, still exists. The left drum-head is whole, and of rather cloudy appearance. Hearing has improved. He hears low ordinary voice at twenty feet, also at ten feet, in both ears, but slightly better in right. He has some difficulty in hearing conversation carried on by three or four persons, especially in a warm room.

Right ear: There is a marked vascular condition about the superior portion of the drum-head, and extending down along the malleus handle. The drum-head has a general humid appearance, and there is a beginning opacity just in front of the umbo. There is a small cicatrix, with some fibrous lines, in lower portion of posterior segment. Since this ear was more exposed than the left, the abnormalities seen point to extensive injury followed by almost complete restoration.

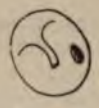


FIG. 37.—BURNS: LEFT DRUM-HEAD.

Left ear: The drum-head has a somewhat humid appearance, due to catarrhal inflammation of the middle-ear. There is a recent perforation in the posterior segment near the edge of drum-head. This is partly concealed by a crust, and gives, on inflation, a whistling sound.

Hearing: Right ear, ordinary voice; left ear, lowest voice, at fifteen feet distance. Watch heard at $\frac{5}{3}$ inches in the right ear, and at $\frac{4}{3}$ inches in the left. This man had both auricles frozen two years ago, while out on the plains.[1]

CASE 6.—Private Joseph Cunningham, 23 years of age, very tall and slender. After the accident patient did not take cognizance of anything for a few minutes, and was dizzy for two days afterward. Has been troubled in both ears since the explosion, especially in the right, which was constantly painful for over a week, and is occasionally so now. He experienced tinnitus aurium, which has not entirely ceased yet. His voice was autophonous and sounded hoarse and unnatural to him in both ears for four days.

Examination of ears.—Right ear: The drum-head is imperfectly developed; it is transparent (as in cases of cicatricial reproduction) and lacks brilliancy. The short process protrudes unduly. There is a crust on the margin of the posterior segment, and a slight opacity below the umbo.

Left ear: The same general appearances of the drum-head are present as in the right ear. The outlines of the malleus, however,

[1] Private Burns was seen at the writer's office, February 19th, 1888. He said then that he was very sensitive to loud noises in the right ear, and after firing had pain in the ear and head. He also experiences tinnitus like "steam" and "jumping" sounds in the right ear when lying upon it at night. Examination shows the right drum-head to be red about the upper posterior quadrant. The left drum-head shows no redness. There is a lack of brilliancy in both membranes. The first upper left bicuspid is a mere shell, and there is much tartar on the upper and lower front teeth. There is also a tendency to ozæna. Hears low voice in both ears at twenty feet.

are much more prominent. The long process of the incus and its attachment to the stapes is very plainly seen through the drum-head. Just posteriorly to the short process a small area of the membrane is much thinner than elsewhere and seems sunken.

Notwithstanding these abnormalities, the patient gives no history of previous ear trouble, and there is a strong probability that the appearance is due to reproduction succeeding almost complete destruction of both drum-heads from the explosion.

Hearing: Right ear, low voice, with difficulty; left ear, lowest voice, at fifteen feet distance.

CASE 7.—Private Thomas Cramer, aged 39, was standing with back toward shell, but the right ear was a little more exposed than the left; felt a stinging sensation from the concussion "all the way up the left side from the foot to the ear." Has felt nothing since. The ears were apparently uninjured. It is difficult to account for the escape of the ears from injury in this case.

Hearing: At fifteen feet distance, lowest voice in both ears, but best in right.

CASE 8.—Corporal Ingram, 32 years of age, felt stunned for a minute or so, but had no pain or vertigo; in fact, had no aural symptoms whatever.



FIG. 38.—INGRAM: LEFT DRUM-HEAD.

On examination it was found that both ears contained considerable soft cerumen. Patient had accumulation of wax syringed from both ears in 1883. As no symptoms of injury to the hearing organs had appeared, it was thought probable that the presence of this accumulation of cerumen had been the means of protecting the drum-heads from the injurious effects of the explosion. This, however, does not appear to have been the case. When the cerumen was removed a few days later, it was found that the quantity was not sufficient to occlude the canals. The right and most exposed drum-head looked well; it was probably protected from the concussion by the heavy wooden structure upon which the mortar was mounted. Behind the wax, however, in the left ear, which was turned from the shell, was a quantity of inspissated purulent matter and epithelium. When this was removed, the drum-head was found to be red and angry-looking, and the landmarks were not seen. Syringing produced a feeling of faintness and nausea.

Hearing: Left ear, ordinary voice only; right ear, low voice at fifteen feet distance.

December 4th.—There has been no discharge from the left ear, and parts have cleared up slightly, showing great arrest of development, the short process and posterior fold being very prominent; otherw

the landmarks are hardly distinguishable. The entire membrana vibrans is, apparently, in a necrotic state, indistinguishable from the inner wall of the tympanum. A very thick desquamative collection lies at the site of the anterior inferior segment.

December 21st.—There has been no discharge or pain, and the parts are dry. It can be seen that the entire membrana vibrans has been destroyed, excepting a thin edge remaining attached to the posterior wall of the tympanum. Patient thinks hearing in the left ear has improved. He has no tinnitus, vertigo, or ausea.

Hearing: Left ear, low voice at fifteen feet distance; as tested by König's rods, fifty thousand vibrations per second perceived in both ears.

The diagrams of the drum-heads injured were drawn by Dr. C. J. Colles. The dark shading marks the extent of loss of substance in each case; the lighter indicates the presence of cicatricial tissue. In the case of Cunningham no diagram is given, since the parts were probably almost entirely reproduced.

Remarks.—As might have been expected, the immediate effect of the severe concussion caused by the blast of the explosion just described was dumbfounding in the extreme, so far as most of the persons in the immediate vicinity were concerned. The mental confusion which ensued in some of the cases lasted a long time, and in one instance, that of Corporal Clark, it is doubtful if complete recovery ever takes place.

In some of the cases the absence of prominent symptoms of injury of the ear, such as pain in the organ, tinnitus, deafness, or discharge, was noticeable. Soldiers are, however, as a rule, accustomed to endure hardship without complaint, and, in fact, all insensitive persons are liable to overlook ear disease until incapacitated to perform their work. It was only after persistent inquiries were made that some of these persons would admit that they had suffered any injury of the ear.

The writer has obtained some facts in conversing with officers who served during the war of the rebellion, which may be of interest here. Commander Robeson, at the naval attack on Fort Fisher, found that the continued explosion of fifteen-inch shell at close quarters gave rise to very disagreeable ringing in the ears, which finally benumbed the hearing sense so much that he could not hear an order given on deck for several days; the disability, however, was but temporary. Dr. Delavan Bloodgood, Medical Director U. S. N., informed the author of a case where deafness was said to be "from concussion of the cannon" in an action on Lake Champlain, July 3d, 1813. The case was that of Captain Sawyer, U. S. N., who was a midshipman on

board the sloop Eagle, which was sunk by the British flotilla, aided by troops on the shore. The engagement lasted four hours; and the captain was afterward taken to Halifax and confined on board a prison-ship over seven months. It is probable that exposure subsequent to the action very much increased what might have been but a temporary difficulty. On the cessation of the retaliatory hostage system, he was immediately ordered to the Constitution, and afterward served in the Brazilian, Pacific, West Indian, and Mediterranean squadrons, and was finally surveyed and condemned, on account of deafness, in 1822.

The writer is in receipt of a communication from Medical Director Henry O. Mayo (retired), U. S. N., giving his own experience as to the effect on the ear of the concussion of great guns, which is of much interest, as showing the effect of repeated injuries. He says: "I first felt the effects of concussion from big guns in the summer of 1861, on board the frigate Savannah, while engaged in a scrimmage with some rebel gunboats at the mouth of the James River. As the affair promised to be of a bloodless character, from the respectful distance kept by the enemy, I seated myself in the bridle-port, on the gun-deck, to watch the performance. My hearing was quite impaired for a day or two, but in a short time the effects of concussion passed off entirely.

"Just at the close of 1864 I was attached to the U. S. S. Powhattan, of Admiral Porter's fleet, and was engaged five days (three at one time and two at another) in the bombardment of Fort Fisher, and the other batteries at the entrance to Wilmington. Having occasion to go on deck at times during the action, I could only do so by the cabin companion-way, which was but a few feet from the eleven-inch pivot gun. This chanced to be discharged two or three times, just as my head was about on a level with it, going up or down the hatch, and the concussion was tremendous. Once I thought the gun had burst, and taken my head along with it! Upon reaching home, a month or two afterward, I found the hearing of the left ear much impaired, but the right still served me so well that I was enabled to continue my ordinary duties on the active list.

"In the early part of 1870, I went to China as surgeon of the Asiatic fleet. During this cruise I was exposed for one entire day to the concussion of big guns engaged at target-firing on board the flagship Colorado. This gave the *coup de grace* to the hearing of the left ear, and still further impaired that of the right. In 1875, I was retired on account of deafness."

Dr. Mayo is of the belief that the cause of the defectiveness lies in

the transmitting mechanism of the middle ear, and not in the inner ear or auditory nerve tract. *The Eustachian tube of his left* (worst) *ear has always seemed abnormally pervious, while the right was considerably obstructed.* He cannot hear the loudest-ticking watch pressed against the left ear, and only faintly in the right, but can converse pretty well with *one* person at close range, who speaks slowly and distinctly.

It would seem difficult, in cases where chronic catarrh of the middle ear already existed, to determine the exact amount of injury due to this cause and to concussion, respectively. It is probable that where rigidity or fixation of the transmitting mechanism existed from catarrh, the ear would thus be made more sensitive to concussion. On the other hand, it is found that boiler-makers, who appear to have their catarrhal deafness increased by the terrific concussion from riveting boilers, do not usually complain of hyperæsthesia or of painful sensations therefrom. But this is, perhaps, a question of sensitiveness to such impressions.

Among other instances known to the writer, the following are of interest: General Leonidas Polk, a few days after the battle of Belmont, was standing at the breech of an eight-inch rifled gun, which, on being fired, burst and exploded a magazine of fixed ammunition immediately underneath the piece. The captain of the battery and four or five others, who were standing near, were killed. General Polk was very miserable for a few moments from the shock, and was confined to his bed for some ten days. The left ear began to discharge the day of the injury, and continued to do so until he was killed, two and a half years later. He had no previous aural trouble, and the deafness following the injury was the cause of much worry.

General Imboden, in an article in *The Century Magazine* for May, 1885, states that at the battle of Manassas he squatted under the muzzle of a smooth-bore six-pounder brass cannon, when it was fired off; the concussion, he says, threw him twenty feet away, causing momentary unconsciousness. There was a gush of blood from the left ear, which has been deaf ever since.

Another case is as follows:

David McConnell, late a private in the 132d N. Y. Volunteers, came to the New York Ear Dispensary Nov. 14th, 1879, at which time he was an inmate of the Soldiers' Home 205 West 39th street. He stated that in May, 1864, whilst leaning against a strong planking outside of a log building, in which some torpedo shells were stored, three of the latter exploded simultaneously, by accident. The shells were "about the size of a pork barrel." Patient was thrown about four yards by the force of the explosion, his clothing on the

; side being torn off down to the foot, and the left shoulder much
erated. He was sent to a hospital, where the left ear began to dis-
rge. He suffered for months with distressing tinnitus aurium and
igo. When examined by the author, a perforation in the drum-
l was found, and chronic purulent inflammation of the middle
Hearing was considerably diminished. Patient received a pen-
of two dollars a month in 1865, "on account of deafness and
tration of nervous system." This was increased to $8 a month
881, to $9 monthly in 1884, and in 1885 to $12 a month. In a
it letter to the writer, McConnell says that the discharge from
ar has ceased, but that the vertigo remains. He cannot hear
oudest ticking watch in the left ear.

e following case, also an applicant for pension, came to the New York Ear Infirmary, July 17th, 1877.

This patient, Bernard Cunningham, stated that he never had any aural affection until after the battle of Gettysburg. He was a private in Company G, 80th N. Y. V., and states that on July 1st (1863), a shell exploded near his left ear, from the stunning effects of which he did not recover for a quarter of an hour. On the third day, a thin muco-purulent discharge was noticed coming from the left ear; it soon assumed a purulent and offensive character. Patient said that an aural injury was diagnosed by Regimental Surgeon Laughan soon after the injury was received.

When the patient was seen, fourteen years had elapsed since the accident, during which time he had never been free of distressing tinnitus, which was compared to the constant escape of steam under high pressure, with interruptions synchronous with the heart's pulsation. Autophonous phenomena were experienced, and he felt that, unless some relief was obtained, he should become insane. The deafness was variable—at times very great; usually he could hear a loud voice only in the left ear.

Examination showed the external auditory canal to be greater in calibre than the average, and the drum-head, which was correspondingly large, had a circular perforation in the posterior-inferior quadrant about three millimetres in diameter.

In the certificate of disability given this soldier, it was stated that the opening in the drum-head would probably never close, and since there would be a tendency to frequent exacerbations, on account of the exposure to which an out-door laborer is subject, the discharge and autophony, though temporarily alleviated by treatment, would probably never cease altogether.[1]

The following interesting case, taken from the report of the

[1] The Commissioner of Pensions, the Hon. John C. Black, informs the writer, in a letter dated February 7th, 1887, that Cunningham is now a pensioner "at the rate of two (2) dollars per month for disease, and deafness of the ear."

Surgeon-General of the Army for 1886, was reported by Surgeon C. H. Alden, U. S. A., Fort Snelling, Minn.:

John Kerston, a private in Light Battery F, Fourth Artillery, 24 years of age, a Belgian by birth, with no history of previous aural or throat disease. In June, 1885, while salute was being fired, patient became suddenly deaf in the left ear. The hearing, however, returned in a few hours, patient remaining on duty. This was followed in a few days by some pain in the ear and a slight discharge. A week afterwards, when the patient first presented himself for treatment, examination of the left ear showed a somewhat gaping slit in the lower anterior quadrant of the membrane, extending from the umbo to the circumference. There was some sero-purulent discharge. Both drum-heads were dull and uneven in appearance. Eustachian tubes impervious. Hearing in right ear slightly impaired; in the left, ordinary conversation voice at four feet only. Some tinnitus. Left membrane healed four days later. Hearing in left ear then for ordinary conversation six feet. Patient experienced no further trouble until some two and a half months later, when, during a drill of his battery, he was inadvertedly placed near the muzzle of one of the guns. Immediately after the discharge of the piece, patient fell to the ground with a loud cry of pain. When picked up, was completely deaf in both ears. Severe pain in head. Both drum-heads were, on examination, found ruptured in the lower anterior quadrant. Deafness total for conversation and watch, also to tuning fork held against the head. The rents in the drum-heads healed in the course of a few days, and the pain ceased. The hearing, however, did not return, and patient was discharged for disability.[1]

Injuries like the above are especially important in consequence of affording a basis for claims on the government for pensions.

In general, it may be said that the concussion of great guns is much less in the rear of the piece than just over or at one side, and that the more in advance the greater the exposure to the blast. On shipboard a gun's crew is usually stationed from four to eight feet to the rear of the muzzle, and when protected by bulwarks and decks experience no special inconvenience; but if the ear happens to be on the same plane as the face of the muzzle, the effect at a distance of a few feet is disagreeable, or even painful, and causes temporary deafness similar to long-continued concussion previously referred to.

The force of impact upon the drum-head will depend somewhat on the size and curvature of the external auditory canal and the rigidity of its cartilaginous walls; of course, the more straight and large the passage the greater the injury.

[1] Dr. Alden, in a letter to the author, says that Kerston was seen about six months after his discharge from the service; that his hearing had improved slightly, ordinary conversation voice being heard at about the distance of a foot.

The size and tensile strength of the drum-head must be taken into account; if large, and brittle from trophic changes, it is much more easily ruptured.

The facing of the person exposed must also be considered—usually the ear directed toward the object from which the concussive force is propagated suffers most—but in the case of Ingram it was otherwise, the sound-waves having been reflected.

The immediate effect of the blast-impact in the cases injured by the shell explosion at Sandy Hook was undoubtedly upon the exterior surface of the drum-head mainly. While it is true that atmospheric tension is almost equal on both sides of the drum-head, yet a current of air passes much faster along the comparatively large tube comprising the external auditory canal than along up the small Eustachian tube, and hence in most of these cases the drum-head was driven in and contused against the inner wall of the tympanum and retained air with great force. The effect of such violent concussion is to cause necrosis of the membrane.

The momentum of sound-waves may ordinarily be estimated by the application of the law of central forces—the force being inversely to the square of the distance; the effects, practically, of such intense concussive force, however, cannot be measured by rules governing sound ordinarily, since it has been found by experience that, instead of finding himself surrounded near the breech of the gun by highly rarefied air, the experimenter may be subjected to quite an opposite condition, namely, one of condensation. In the former, intra-tym-tympanic air would rush outwardly, pushing the drum-head before it. In confirmation of this allegation the puzzling experience related to the writer by Captain Shaler, U. S. A., may be cited: The window-panes of the officers' quarters at the testing-grounds at Sandy Hook, situated some three to five hundred feet to the westward of the gun-park, are liable to be shattered by the concussion of large pieces in practice, and it has been found that *the glass is forced outward at one time and inward at another.* Regarding the drum-heads as window-glass under like conditions, we might find them ruptured by compression from without in one instance, and by distention of intra-tympanic air in another.

All of us are aware of the difficulty of ascertaining the source of sound in a sea-fog, where aqueous vapor-tension varies in a much greater degree than inland. Professor Henry described the reflections of sound which here take place as "acoustic shadows," a picturesque comparison recognizable by every one familiar with those similar phenomena, namely, the reverberatory detonations of thunder during

a storm, where clouds or mountain peaks intervene. It is to the unrecognizable aqueous vapor "peaks" and, even on clear days, the variously heated strata of which the air may be composed, that many unexplained and puzzling acoustic manifestations are due. In the case of Corporal Ingram, cited, the wave from the blast did not nearly so much affect the right ear, which was turned toward the shell, as the left one, the sound having been apparently deflected from its course by the heavy gun-carriage intervening. General Franklin, in describing the battle of Gaines's Mill, in *The Century Magazine*, July, 1885, says it was not heard a mile and a half away; he thinks the dense woods intervening prevented the passage of sound. The "silent battle," as the action at Gaines's Mill has been designated by General E. M. Law, of Lee's army, also attracted the attention of the Confederates; some officers who were near witnesses not hearing a sound of the battle, though the direction of the lines of battle were distinguishable.

The author distinctly saw the troops in action on one portion of the field during the battle of South Mountain; large volumes of smoke were seen to ascend after each discharge of the cannon, and lesser ones from the musketry, and yet the roar and crash therefrom were mostly unheard. On the other hand, the writer recollects hearing the cannonading at the first battle of Bull Run distinctly, though he was with troops more than one hundred miles distant. Although the deadening effects of varying aqueous vapor-tension exercises a notable influence on the behavior of sound, the force of the wind has much to do with the extent of its travels.

Experiments are wanting to determine the windage[1] of balls. This must depend on their size and velocity, nearness of passage, and the force and direction of the wind. There seems to be no doubt but that the windage of a cannon-ball might rupture the drum-head of the ear. The compression of the air before and around the ball, the author has been informed by Professor A. M. Mayer, is considerable, and the *velocity* of the compression is equal to that of the ball, which velocity may even exceed that of wind itself. So, an *aërial blow* of such a mass of air, at such high velocity, is probably quite sufficient to rupture the drum-head.

The size and force of modern military explosives having been greatly

[1] "Windage," it should be said, is a technical term used in military parlance to indicate the difference in diameter between the bore of a gun and its projectile. The word has been, perhaps improperly, adopted by writers on military surgery, in which sense it refers to the impact of the condensed air surrounding a missile passing near any part of the body.

increased of late years, much more injury to the ear is likely to occur in future than has been recorded of the past, though the number of accidents from premature discharge or from exposure to the blast in firing breech-loading pieces must be less than when muzzle-loaders were in vogue.

The extent of the injury of the drum of the ear in each one of the cases reported was dependent on the distance from the shell, the facings at the moment of explosion, and the size of the external auditory canal. In some instances, as, for example, in the cases of Abbott, Clark, Goodno, Ingram, and Sinclair, the drum-heads were driven in with such force as to cause their complete destruction by death of the tissues. In some of the cases, it will be observed that partial or entire reproduction of the drum-head took place. The spontaneous cure, in most these cases, without leaving any discharge, affords a valuable suggestion in the treatment of inflammation of the ear, as well as in operations on the organ, in healthy persons. It is believed, notwithstanding the great destruction of the membrana tympani, that the chain of ossicles has been left in every case. It is fortunate for man that great augmentation of tension, exerted either from without or from within, upon the transmitting mechanism of the ear, may be experienced without serious injury to the stapes or labyrinth.

It is the experience of many officers that the vibrations of great intensity which are given off from some field-pieces and bursting shells, charged with high explosives, are more disagreeable than the heavier sounds of great guns. The metal itself vibrates under these circumstances similarly to a tuning-fork.

A very disagreeable jar is imparted to the temporo-maxillary articulation when the individual is near a great gun being fired off. This is lessened, it is believed, by standing on the toes and leaning forward. Some simple precaution, to be employed by officers and men during artillery practice, would seem very much needed, since aural shock is not only painful and distressing, but orders cannot be well heard while the confusion lasts. It would, furthermore, seem advisable that artillerists should stand facing the piece whilst it is being fired, as the force of the concession would then be very materially lessened, as far as the ear is concerned. The case of Dr. Mayo, above given, is of interest in this respect, as showing the disagreeable effects of sudden impact of sound from an unexpected source coming directly upon the ear.

There is probably no better protection than a firm wad of cotton-wool well advanced into the external auditory canal. In suggesting

this protection, it is believed that harm can seldom take place from pressure of air from within, since it is known that the violent introduction of air into the tympanum from the throat, by means of Politzer's method of inflation, seldom ruptures the drum-head, though, if such a volume of air were suddenly driven into the external auditory canal, and the drum-head would often be ruptured.

B. THE CONCUSSION OF THE BLAST OF SMALL ARMS AND EXPLOSIVES.

The ear is not liable to injury from the so-called windage of missiles of small arms; but when in the blast of light explosives, rupture and other injuries of the drum-head may take place.

The following are examples:

CASE 1.—Male, 21 years of age. One year and a half ago a horse pistol was fired off close to his right ear. For a few days he experienced noise and pain in the ear, but deafness was not observed until six months afterwards. The right drum-head is densely opaque, but there is no cicatrix. The deafness seems due as much to chronic head catarrh as to the concussion. Canals large.

CASE 2.—Male, 24 years of age. Six weeks ago, on July 4th, a pistol was fired off close to his right ear, which was previously unaffected. There were no symptoms at the time, but, on awaking the next morning, he found the ear was discharging. It has run ever since. Tinnitus existed for six months, "like the striking together of pieces of metal or glass;" it was intermittent. Some inspissated pus was removed from the right ear; the drum-head was dull-looking, and in the inferior segment a perforation was filled with granulation tissue. The canals were large.

CASE 3.—Male, 32 years old. At age of eighteen years, a pistol was fired off near his right ear. There was much tinnitus, and, later on, a discharge, which has existed ever since. Hears now loud voice only in right ear. The perforation is concealed by secretions. Canals are large. Patient seen only once.

CASE 4.—Patient, male, aged 7 years, comes with the statement that yesterday, July 4th, a boy exploded a fire-cracker "into the left ear." There has been much pain ever since, but no deafness. The left drum-head is inflamed looking; the inner end of the canal is desquamating. Only seen once.

CASE 5.—Female patient, aged 64 years. On July 4th, a month ago, a young man fired off a pistol twice within two or three feet of her left ear, causing immediate deafness and autophonia, which still exist. No pain was experienced. The drum-head is opaque, but no evidence of any rupture remains.

C. FROM LONG-CONTINUED MUSKETRY FIRE, RAPID-FIRING MACHINE GUNS, ETC.

It has always seemed to the writer that exposure of the drum-head to the long-continued shock of musketry fire was injurious, though no case of deafness was traced to this cause while in the field. The following case, referred to him by Medical Director Delevan Bloodgood, U. S. N., however, seems to confirm the above conjecture. For its history the author is indebted to Passed Assistant Surgeon Frank Anderson, U. S. Steamship Richmond.

David C——, ordinary seaman, 23 years of age, on October 27th, 1887, was engaged in firing at a target with a Gatling gun in the bow of a ship's cutter. He stood about two feet from the muzzle of the gun, passing ammunition, and to leeward of it, his back toward the bow, the left ear at first turned to the piece, but when standing erect, some foot and a half above it, during the firing of a thousand rounds of cartridges. The firing occupied about fifteen minutes. The discharges were in volleys of two hundred each, there being about two minutes' interval between each volley. Patient became so deaf after about four hundred rounds had been fired, that he could no longer hear the orders given by the man feeding the gun. He therefore turned about while passing the rest of the ammunition, so as to bring the right ear, which seemed less affected, toward the piece, turning half round when reaching for cartridges. There was a "stinging pain" in and about the ears, extending through the head, especially the forehead, and when the last shot was fired he "could not hear anything." On returning aboard ship, about fifteen minutes afterward, he found that the deafness was, if possible, increasing, and in about a quarter of an hour it was total. The head pained for some two weeks, and there was vertigo; the pain behind the ears and sensitiveness to touch, especially on the left side, still continues.

The left mastoid was blistered while on ship, where he remained three weeks after the injury. At first he was very nervous and could not sleep well on account of the noise and distress in ears and head, though he felt very drowsy. He is now in the Naval Hospital, where the left mastoid has been blistered three times and rubbed with oleate of mercury, and he is under a moderate course of iodide of potassium. The patient is of full medium size and has been in good health, though he never considered himself very strong. There is no history of any constitutional disease, and he says his hearing has always been very good. When examined by the writer (January 18th, 1888), he did stagger, but occasionally felt a sensation, lasting a few minutes, as if something was turning around in his head. He has lately complained of slight "weakness" of the left eye, probably due to slight paresis of the facialis. He is much run down and mentally depressed.

Examination of ears.—Left ear: The drum-head shows trophic changes; at the umbo and posterior segment, radiating fibres are exposed to view. Short process very prominent. Stapes and long

process of incus are plainly visible through the drum-head. There has been very decided chronic catarrhal otitis media. The entire peri-auricular region is tender to touch, though no other part of the head is. *Right ear:* Some symptoms of recent chronic catarrh are present. The drum-head is less trophic than the left. The cone of light is high up, above the umbo. Malleus plexus and tissues about the anterior-superior quadrant are very decidedly injected.

Hearing.—At the sham battle which took place at Newport, after his injury, he was on deck of the Richmond and saw the action, but could hear no sound, not even the guns of his own ship, though he felt the deck tremble. The deafness is absolute; cannot hear any impression of sound. Large vibrating tuning-fork on teeth or any part of skull not heard. Does not hear shouting or screaming into the ear through a conical conversation-tube. Patient does not hear his own voice, but speaks with very good modulation.

The importance of facing the piece in firing is shown by the result of neglecting such a precaution in this case, where the ear was presented to the muzzle—the effect of impact being greater owing to the direction of the wind. Nor were the ears protected by cotton-wool in the external auditory canals, which were large. It may be remarked that the regularity and frequency of the impacts of intense sound upon the drum-head were sufficient in this case to produce neuritis of the auditory nerve, though the drum-head was not ruptured. The intense vibrations of the barrels of the Gatling gun, when rapidly fired, are very distressing to hear, even at some distance to the rear. They seem to vibrate much in the same manner as a tuning-fork.

Colonel Alfred Mordecai, of the Ordnance Department, U. S. A., informs the writer that the effect on the ear of volleys from rapid-firing machine guns are, even at some distance, exceedingly disagreeable, especially when fired with the rapidity of 1,200 rounds per minute. These guns, for practice, are seldom fired more rapidly than 100 rounds per minute, though in the above recorded case the rate was at about 200 per minute.

D. FROM THE IMPACT OF INTENSE SOUNDS PROCEEDING FROM STEAM WHISTLES, LOUD VOICE, AND METAL HAMMERING.

All very loud sounds are generally regarded as disagreeable, and if long borne may not only irritate the transmitting mechanism of the drum which is thus kept unduly active, but the perceptive apparatus and central auditory tract may suffer from irritation also. The following cases are examples :—

Screaming in the ear.

Male, 20 years of age. Eight months ago, while out boating, his companion, a woman, came close to his right ear with her mouth and screamed: "What did you say?" in the highest pitch of her voice. This caused immediate pain and tinnitus like loudly-ringing bells. He was perspiring freely at the time, and feeling tired lay down in the boat and slept for two hours in the night air. For two days afterwards he was "hoarse," and thinks he had a "cold." Three weeks later he experienced deafness in the right ear and "numbness"; these symptoms have recurred once or twice.

Examination showed that the distress was due to a collection of cerumen, which having become loosened whilst he was perspiring, was impacted by the sound of the woman's voice, and thus caused a slight inflammation of the drum-head.

Rupture of drum-head from a locomotive whistle.

Daniel McLaren, Esq., consulted the writer in 1873. He was then 54 years of age. He stated that twenty-four years ago, whilst an engineman on the Boston and Worcester Railroad, he blew the whistle of his engine while passing under a roadway. He was standing with the left ear toward the open window of the cab, thereby exposing it to the intense sound. The drum-head was ruptured, as shown by the cicatrix remaining, and hearing has been defective ever since. Mr. McLaren, subsequently President of the Cincinnati, Hamilton and Dayton Railroad Company, having become somewhat deaf in the right ear from otitis media chronica, suffered much greater inconvenience from the defect in the left ear than ever before.

Injuries of the ear from the intense sound produced by steam whistles are not uncommon. The Superintendent of the Amboy Division of the Pennsylvania Railroad Company, informs the writer, in a letter dated January 23d, 1888, that an engineman was overcome recently by the prolonged and intense sound of a locomotive steam whistle; he blew his whistle for a road crossing and the valve, getting out of order, refused to close. The whistle continued blowing until the train stopped at the station. The man was so near the source of the sound that he became vertiginous, and it was necessary to lift him from his engine and assign another man to his place. Others around the train were affected disagreeably, but none so severely. The man recovered from the shock to his nerves in a short time.

Metal hammering.—Operatives exposed to the intense noise of metal hammering experience more or less injury of the ears according to the violence of the vibrations and the condition of their ears. Deafness in these cases is much more likely to arise from the impact

of sound where sclerosis resulting from inflammation of the mucous membrane of the middle ear already exists.

The healthy ear is, however, less liable to injury in this way. Boiler-makers are nearly all of them a little deaf, but as with artillerists and caisson-workers, it is not easy to estimate the amount of impairment due to either cause respectively. Most boiler-makers seem to hear best in a noise, and they always converse while at work. The writer has been informed by employers that some men, even after working at boiler-making for forty years, do not experience any deafness.

The following cases are illustrative:

CASE 1.—Patient, a tinsmith, 33 years of age, stated that a year previously he was employed during one day in riveting a large cast-iron water tank. His work consisted in holding a hammer against the inside of the tank while another mechanic hammered upon the rivets on the outside. His right ear was exposed to the terrific din during the entire day, not being more than one foot away from the source of sound. The following day the patient found that the right ear was very deaf, and since then the deafness has remained about the same.

Examination showed evidences of long-standing chronic middle-ear catarrh on both sides.

CASE 2.—Patient, 34 years of age, has been a metal hammerer for eighteen years. From the beginning had tinnitus in left ear, and this he believes has been greatly increased by noisy work on metals, as riveting and the like. When he stopped working there was so much "whistling" in the ear that he finally became afraid to work any longer. On examining the left ear, the canal was found filled with pus, débris of inspissated wax and epithelium, the drum-head being absent. The malleus remained, held by mere shreds of membrane. In the right ear there had never been any tinnitus.

CASE 3.—Patient, 38 years old, began working at boiler-making fourteen years ago. The first week he was so much affected that he could not hear conversation. He soon got used to the noise and continued this occupation for five years. The canals are large. A large mass of wax was removed from the right ear, showing the presence of two chalky deposits just behind the malleus handle.

CASE 4.—Patient, 50 years of age, had a discharge from the left ear which began at the age of eight years, and lasted for twenty years. When thirty years of age he began boiler-making, following this occupation for six years. During this period his hearing became very bad; he could only hear loudest shouting for an hour after quitting work. He always wore lamb's wool in ears while at work. After he gave up this occupation, his hearing improved.

CASE 5.—For three years, this patient, 21 years of age, has had

variable deafness and autophonia; also tinnitus in both ears. For one year past has worked at sheet-iron riveting, which has very much increased the tinnitus. His teeth are very carious and there is free ceruminal secretion.

CASE 6.—Patient, 61 years old. At the age of twenty-three he had typhoid fever, being afterwards very deaf for nine months. For twenty-four years, from his twenty-sixth to his fiftieth year, he worked in a boiler yard, which increased his deafness very much. Nine years before quitting this work he had autophonia in both ears, but has never had any pain. The canals are large, and from the left a large plug of inspissated cerumen was removed.

CASE 7.—Patient, 67 years of age, has worked in a boiler shop for twenty-eight years. At first the noise in the head on coming out of the shop was very great, and still continues when he stops work. Patient gets overheated at his work and takes cold easily and very frequently. Has been deaf for eight years, and the tinnitus has been worse for three years past. From the right ear a large mass of desiccated cerumen was removed, a small amount from the left.

CASE 8.—Mechanic, aged 38 years, had first noticed deafness while apprenticed at boiler-making, in his seventeenth to twentieth years. After hard blows in the boiler the sound, he said, seemed to pass through his ears, leaving a "sick feeling," as though they were swollen. This would happen several times a day. He heard no better in a noise. He always had been troubled with nasal catarrh, and the drum-heads showed evidences of the existence of chronic catarrh of the middle-ear.

Boiler-makers find that the wearing of cotton-wool in the ears is a source of much protection against the damaging effects of the continual impact of sound on their ears.

5. CONTUSED AND PENETRATING WOUNDS OF THE DRUM-HEAD FROM OBJECTS THRUST INTO THE EAR.

Incised wounds of the drum-head are not uncommon. They are usually caused by the sudden and accidental thrust of sharp objects introduced into the external auditory canal for the purpose of scratching the ear or in play; hair-pins, small pencils and the like, usually in the hands of women and children, often do much harm in this way.

The drum-head is, furthermore, often wounded by the sharp instruments employed by unskilful persons in attempts at the removal of foreign bodies from the ear.

The following are cases in point:

CASE 1.—Male, 33 years of age, first seen, August 23d, 1878. While out fishing with a friend six days ago, the latter was standing a short distance away, holding the handle of his rod against his body with the tip pointing towards the patient's head. Patient, in turning his head, suddenly and violently forced the sharp tip of his companion's rod into the left ear, with a sensation resembling the "snapping of a piano-string." He suffered instantaneous pain and fell over on the ground with a feeling of "spinning around like a top." The rod was now pulled out of the ear and he was able to rise with assistance, though he could not stand or walk unaided. Pain was only noticeable at the moment of injury. He was not unconscious at the time, but when struck was dazed and fancied for the moment that he was falling into the water. He was taken home "as a drunken man would be" and vomited several times. Patient was kept under observation for two months, during which time the vertiginous symptoms were very marked. The perforation was in the posterior superior quadrant of the drum-head.

Patient was not seen again until January 18th, 1888. During the two or three years following the above-named injury, he had two attacks of vertigo in the street. His general health, however, is now good. There is a small manometric cicatrix in the left drum-head at the site of the old perforation. Hearing in this ear for plain ordinary voice at five feet only. There is also constant "buzzing."

CASE 2.—Male, 7 years of age. Seven days ago, he put the blunt end of a hair-pin of medium size into the right ear, when his brother ran against it and forced it deeply into the ear, causing pain and bleeding. The pain is now severe and the discharge purulent. Hears loud voice only. The drum-head is perforated in the anterior-superior quadrant. When last seen, a week later on, the perforation was healing.

CASE 3.—Female, aged 50. Three weeks ago had a head cold with pains in both ears. Four days ago she experienced a tickling sensation in the right ear and introduced a hairpin; there is a perforation in the right drum-head. Seen but once.

CASE 4.—Male, 26 years old. Four days ago, while lying on a lounge, his two-year-old child inserted one end of a slender paper-cutter into the right ear. The father being semi-conscious at the time, jumped up and brushed the paper-cutter aside with his hand, breaking it into three pieces, one of which, over an inch in length, remained wedged in the canal. Some difficulty attended its removal; it was covered with blood. A discharge was not noticed until the third day, but exists now. There has been considerable tinnitus. There is pain and a perforation whistle. He remained under observation for two months before the drum-head healed. Canals were very large.

CASE 5.—Male, aged 20. Two days ago a younger brother waked

him up in the morning by inserting a broom-straw into the right ear. The drum-head was thereby contused, but no pain was felt. In half an hour, however, there was tinnitus and, at night, headache, especially on the right side, and sleeplessness. Hears loud voice only in the injured ear. The posterior superior quadrant of the drum-head was the seat of a large exudation blood cyst. When this finally disappeared, the membrane was found perforated. The wound of the straw seems to have severed a branch of the mallear plexus. Patient was only seen three times.

CASE 6.—Male, 28 years of age. Three years ago, while having a carrier armed with cotton-wool passed into the left ear for the instruction of students, the doctor passed it in too far, rupturing the drum-head, and causing sudden pain, followed in a few days by a discharge. An opacity now marks the seat of the injury.

CASE 7.—Female, aged 27. Yesterday evening her child struck a slate-pencil with which the patient was scratching her left ear. Blood flowed at the time, and the pain in the ear was intense. Headache, tinnitus, vertigo, and autophonia. The drum-head perforated. When last seen, thirteen days after the injury, patient was improving.

CASE 8.—Female, aged 24. Three days ago, in attempting to remove a foreign body from the left ear, a druggist perforated the drum-head with a crochet needle. The patient fainted. Ear was afterwards syringed. Has pain and tinnitus. Hears loud voice only at ten feet. Membrane healed slowly.

CASE 9.—Female, 27 years of age. Eight years ago wounded the drum-head of right ear while picking the ear with a hairpin. The ear bled, was painful, and she had deafness and tinnitus. There is now a purulent discharge, which has probably existed ever since the injury.

CASE 10.—Male, 33 years of age. Two weeks ago a tightly rolled paper lighter was violently thrust into the right ear in play. Pain and tinnitus were immediate and severe for twenty-four hours—since then dull. Perforation whistle on blowing nose. Healing was rapid.

6. INJURY TO THE DRUM-HEAD FROM VIOLENT SYRINGING OF THE EAR AND IN SURF BATHING.

A stream of water in violent syringing, especially for the removal of cerumen, is liable to rupture the drum-head when care is not exercised. The author has seen a number of such cases. One example, however, will be sufficient.

Male patient, 29 years of age. When ten years old, while suffering from eczema of the auricles, the ear was violently syringed out by a physician with a large syringe used to administer enemas. The force of impact upon the drum-head was such as to knock the patient down.

The rupture in the membrane never healed; in fact, the membrane is now almost missing, and there exists a purulent discharge.

The reader should consult Chapter VIII. for an account of the injuries to the ear from bathing.

7. LESIONS OF THE DRUM-HEAD FROM VIOLENT TRACTION ON THE AURICLE.

The act of frowning in certain persons is attended by such contraction of the anterior auricular muscle and the fascia going to the drum-head, that the latter gives forth a "crack" during its responsive movements which not only can be heard by the patient himself, but also by the examiner, if a diagnostic tube be employed. Every otologist must have frequently seen the increased redness of the anterior superior quadrant of the drum-head, owing to increased vascularity, following traction upon the parts, when the auricle is drawn upwards and backwards to facilitate the introduction of a speculum. Very gentle traction even is always attended with more or less injection of the manubrial plexus of blood-vessels.

Pulling the auricle violently is no less cruel than boxing the ears, and is no less common; the lacerations and strains caused in this manner are even more injurious and painful. The membranous canal may be thus lacerated, and since the deep temporal fascia extends down to the membrana flaccida, the drum-head also is often lacerated.

The following cases illustrate this in a striking manner:

CASE 1.—Male, 30 years of age. Never had any aural trouble until twelve years of age. when an English teacher, who was instructing the class "on the endurance of Italians to pain," pulled patient's left auricle to test his endurance. He stood the torture smilingly as long as he could, when the teacher became angry and boxed him on the left ear, knocking him down. This was followed by ringing and deafness in the ear. The ear has troubled him off and on ever since, and examination shows a large perforation in the posterior-superior quadrant of left drum-head leading up into the attic of the tympanum.

CASE 2.—Male, 29 years of age. Five years ago an inmate of Morris Plains Lunatic Asylum violently pulled his right auricle; this was followed by ringing in the ear, which increases whenever he has a head cold. The external auditory canals are so narrow at the osseous portion that drum-heads cannot be seen.

CASE 3.—Male, 10 years of age. Always subject to aural inflammation since having scarlet fever at the age of 4. One week ago, the left auricle was severely pulled, causing a wound on its inner surface and giving rise to pain and tinnitus aurium.

CASE 4.—Female, 11 years of age. While playing with some other

children in front of a shop, the proprietor ran out and seized the patient by the left auricle and, during her struggles to escape, the organ was violently wrung and pulled. She cried out with the pain, which continued for some time; a discharge appeared the next day, and she was brought a few days afterwards, July 14th, 1884, to the New York Eye and Ear Infirmary for relief. An examination of the ear showed that the integument covering the superior wall of the canal and the upper portion of the drum-head was inflamed and exfoliating, and furthermore, that the membrane was lacerated in several places about the umbo. There was a discharge through the perforations from the drum; also deafness and autophonia.

The patient was under observation for about seven weeks, after which she failed to return. The drum-head had not then healed and a purulent discharge from the ear still existed. There was also considerable deafness. On December 4th, 1887, three and a half years after the injury, this patient called on the author, stating that for the past two or three weeks she had had a good deal of pain and discharge in the right ear. On examining the left (injured) ear, it was found that the drum-head was adherent to the inner wall of drum; furthermore that a white cicatrix was present behind the handle of the hammer, which was drawn backwards somewhat. The malleus was displaced downwards. Anteriorly the drum-head had a little brilliancy. Loud ordinary voice could be heard in the left ear at twenty feet distance. She stated that the left ear had discharged off and on until four months ago; that there was tinnitus resembling musical sounds and intermittent pain in the same ear. She left off going to school six months since, as she was so deaf that she could not understand what the teacher said to her. Patient has many decayed teeth. She works at present in a cigarette factory.

CASE 5.—Male, 29 years of age. Has a manometric cicatrix in the drum-head of right ear, with defective hearing and autophonia. The cicatricial tissue is the result of an injury received when he was nineteen years old. Patient had been angrily ordered from his seat in a carriage and, because he could not comply quickly enough, his uncle had caught hold of the right auricle as he attempted to get out, pulling it vigorously afterwards. Blood flowed from the ear at the time and continued to trickle down upon his clothing for an hour. He did not recover for several weeks, and the ear was occasionally the seat of pain for some years. There has been deafness ever since, and very distressing autophonia, due to the manometric cicatrix alluded to above.

CASE 6.—Male, aged 14 years. Three months ago, his brother caught him by the lobule of the left ear, pulling it until some blood escaped from the canal. The ear has discharged ever since and he only hears shouting voice in that ear. The left drum-head is hyperæmic, the inner end of canal, which is large, is red, dry and exfoliating.

A month later, when patient was last seen, the drum-head had healed.

CASE 7.—Male, 37 years of age. Fifteen years ago had his right ear severely pulled, causing a "click" in the ear. Pain was severe and in about two days there was a discharge lasting a month. Came on account of neuralgic pains in right side of head and right ear. There is no cicatrix in the drum-head to indicate the site of any injury.

CASE 8.—Male, 23 years old. Two days ago, left auricle was seized by the teeth of a man during a fight. The lobule was much torn, and the traction made on the auricle lacerated the superior membranous wall of the canal, where it enters the bony portion. The membrana flaccida was also lacerated at its anterior insertion. The parts were still bleeding, and the neighborhood very much injected. There was no deafness. Patient seen but once.

8. INJURY TO THE DRUM-HEAD FROM VIOLENT INFLATION CAUSING SUDDEN CONDENSATION OF AIR IN THE DRUM.

The strain upon the drum-head from violent inflation, especially where the Eustachian tube is abnormally patulous, sometimes causes its rupture. This may occur from the use of the air-douche, from blowing the nose, coughing, and sneezing. The following are examples of this accident:

CASE 1.—Male patient, aged 51 years. Several days before coming for treatment, on blowing the nose violently, heard air escape from the left ear. Two or three days later on, there was much pain in the ear with hemicrania of the left side and pain in the left temporo-maxillary articulation on mastication; a discharge from the ear soon occurred and now continues. The exact seat of the perforation cannot be located on account of the swelling and secretion present.

CASE 2.—Male, aged 9 years. Patient had recently recovered from acute purulent inflammation of the right ear, a large perforation being closed by cicatricial tissue. Valsalvan experiment caused rupture of the newly-formed closure. Discharge, however, did not return.

He was advised to avoid blowing the nose, and, on his returning some months afterwards, the perforation was found to have closed up again.

CASE 3.—Male, aged 33. Is a consumptive and has nasal hemorrhages. Three weeks before coming he had sniffed up a warm solution of alum, and commenced blowing the nose when he felt something snap in the right ear; ever since there has been autophonia, tinnitus, and pain in the ear, the latter extending to the vertex and down the neck. There is a feeling of soreness about the auricle. The right drum-head and adjacent portion of the external auditory canal are acutely inflamed and desquamating, but the perforation cannot be

seen. He is deaf in the affected ear to voice spoken below ordinary tone close by the ear.

CASE 4.—Male, 42 years of age. During severe paroxysms of coughing "felt something turn in the left ear," and afterwards there was severe pain in the left temporal region for twenty-four hours. The tinnitus existing at first has ceased, but there is yet decided autophonia. Examination showed a perforation in left drum-head (which was hyperæmic) just below the umbo. There was no discharge.

CASE 5.—Male, 64 years of age. Is rheumatic, and has long had deafness in the left ear. On swallowing, there is always a "squeaking" sound experienced in the left ear. Whilst coughing violently last winter, something was felt to give way in the left ear, and deafness and tinnitus were increased. Examination shows a recently formed cicatrix in posterior segment of left ear, partially closing the rupture, but there is no perforation whistle on inflation.

CASE 6.—Male, 34 years of age. Was recently the subject of acute catarrhal inflammation of the right middle ear; on violently blowing the nose, sudden pain was experienced in the affected ear and side of the head, with ringing noises and a perforation whistle.

These cases, familiar to otologists, are very often met with, and examples might be cited *ad infinitum*, but the above will serve to impress the reader with the importance of cautioning all patients to avoid blowing the nose violently while healing of the drum-head is taking place. It is obvious, of course, that the meddlesome practice of inflation of the drum by any method should be avoided at this time.

Blows upon the nose may cause sudden condensation of air in the drum. For example, a male, 44 years of age, run down and of dissipated habits, received a severe blow upon the nose two months ago, causing, as he alleges, fracture of the nasal bones. Soon after there was buzzing and deafness in the left ear. Three weeks later on, there was pain over the whole temporal region, and in about two weeks more swelling appeared over the mastoid process. The swelling continued for three weeks, when it was found that an abscess had formed. The pus was evacuated. The drum-head, on examination, showed evidences of inflammation of the attic of the tympanum; secretions, however, did not escape through the drum-head, but escaped by burrowing underneath the integument, finally forming the post-aural abscess. Patient recovered in about five weeks. The following case is also of interest in this connection:

Male, 40 years of age. Twelve years ago, while laying back in a barber's chair to be shaved, a friend, in sport, dashed a soap brush filled with lather forcibly up against his nose. This caused a feeling

of distress in the nose, and after sneezing and blowing the nose freely to obtain relief, he "felt something go up to right ear," causing much pain. An hour after the accident, the pain increasing, he went to a drug-store where chloroform was instilled into the ear, greatly increasing his suffering. The pain continued for a couple of days, and the ear soon got well. Two years ago, however, a friend, in play, slapped him on the same ear with the open hand, when he "felt the air violently forced into his head." The ear was tender for a few days, but there was no tinnitus or discharge. The patient gave a history of syphilis, and has been in a private asylum for inebriates. For two or three months there has been distressing tinnitus and great deafness in the right ear, the drum-head of which has large opacities.

For information concerning injuries, etc., to the ear arising from *diving, caissons, tunnels,* etc., the reader may consult chapter XIX.

CHAPTER XI.

REMARKS ON THE ANATOMY OF THE MIDDLE EAR.

Before entering upon a description of the diseases of this region, a brief but practical review of the anatomy of the middle ear is given at this place for convenience of reference.

According to Leidy,[1] the *auditory plate*[2] forms a broad archway between the mastoid and post-glenoid process, and extends inwardly as the roof of the external auditory meatus in the adult. "The inner extremity defines the meatus from the tympanic cavity by an acute curved ridge, from which a wide crescentoid plate, the *tympanic scute*, slants upward, and forms the outer boundary of the upper portion of the tympanic cavity. The scute is separated externally from the rest of the auditory plate by a spongy substance, but occasionally is continuous through thick, compact substance. Its anterior border joins the tympanic segment, and its posterior border is continuous with the spongy substance of the outer wall of the mastoid antrum."

"The inner surface of the mastoidea forms part of the posterior cranial fossa. Contiguous to the petrosa, it is impressed by the large curved channel for the lateral sinus."

A portion of the anterior surface of the petrosa constitutes the *tegmen*, a wide triangular plate covering the tympanum, the mastoid antrum, and the beginning of the Eustachian tube. "The under part of the tegmen is commonly formed by a layer of spongy substance of variable thickness," says Leidy, and its upper surface is "more or less defined by a fissure, remaining as part of the petro-squamosal suture which, at birth, extends from the notch at the bottom of the squamosa to that of its upper border. Frequently, also, a vascular groove, and several foramina for the transmission of vessels, mark the line of separation."

[1] A Study of the Human Temporal Bone. Science. May and June, 1883.
[2] Lamina auditoria.

The tympanic cavity is divided by Leidy into two portions: "the main chamber, which may be named the *atrium*, situated directly opposite the external auditory meatus; and a recess above this, which may be distinguished as the *attic*." The atrium to superficial observation has been too often regarded as constituting the tympanum, but of far greater importance to the otologist is the attic, which lies above the point blank range of vision in inspecting the middle ear. The *attic*[1] of the tympanum, pyramidal in shape, is situated over the atrium, and above the tympanic orifice of the external auditory meatus. It is separated from the cranial cavity by the tegmen. "Its inner boundary is a convex prominence produced by the contiguous portions of the external semi-circular and facial canals. Its outer



Fig. 39.

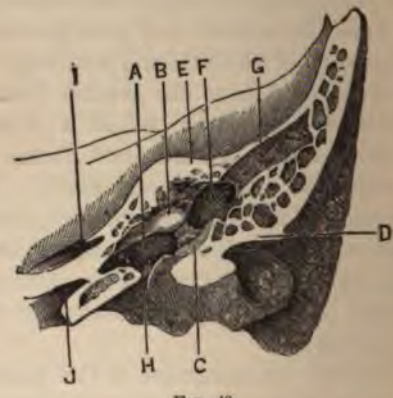


Fig. 40.

Fig. 39.—View from within of the outer Portion of the left temporal Bone, sawed through the Tympanum, fore and aft, parallel with its Inclination (from Leidy).

A, tympanic margin of the external auditory meatus, formed below and at the sides by the grooved margin of the tympanic plate, and above by the margin of the auditory plate; *B*, scute, forming the outer boundary of the attic; *C*, tegmen; *D*, mastoid antrum; *E*, prominence of the inner posterior boundary of the attic; *F*, canal for the accommodation of the long process of the mallet; *G*, petro-squamosal fissure. Below *E* are seen the pyramid and the aperture of the tympanic cord.

Fig. 40.—Section of the left temporal Bone through the Squamosa, immediately in advance of the external auditory Meatus (from Leidy).

A, atrium of the tympanum; *B*, prominence on the inner back part of the attic; *C*, scute at the outer part of the attic; *D*, auditory plate; *E*, tegmen; *F*, mastoid antrum; *G*, anterior passage of the same; *H*, canal for the long process of the mallet; *I*, hiatus of the facial canal; *J*, Eustachian tube.

boundary is the wide crescentic tympanic scute of the auditory plate. It opens above the prominence of its inner boundary, outward and

[1] "Atticus tympanicus, upper chamber of the tympanum of Huxley."

backward, by a large aperture[1] into the mastoid antrum. Beneath, it opens into the atrium by an elliptical aperture, formed internally by the ridge of the facial canal, and externally by the tympanic margin of the auditory plate. The attic is partially occupied by the mallet and anvil, which thence, by the handle of the former and the long process of the latter, extend into the atrium."

"The *mastoid antrum* is a prolongation of the attic backward and outward in the spongy substance of the mastoidea. It is of variable

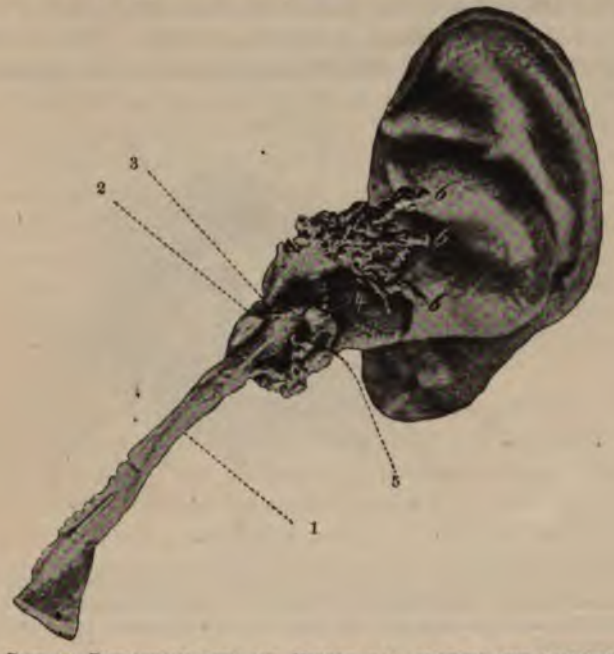


FIG. 41.—CAST OF EUSTACHIAN TUBE AND MIDDLE EAR, SHOWING THE RADIATION OF THE CELLULES SPRINGING FROM THE ANTRUM (FROM BEZOLD[2]).

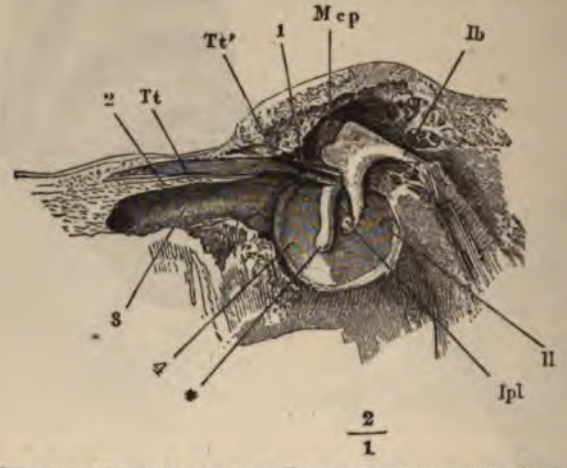
1. Isthmus tubæ. 2. Roof of the tympanum. 3. Incisura transversalis. 4. Sinus tympani (Steinbrügge). 5. Niche of the fenestra rotunda. 6, 6. Cellules radiating backwards and downwards from the antrum.

size, ordinarily ranging from that of the attic to double the dimensions of this. It sometimes ends in a blunt flask-like recess, but is oftener more or less extended downward among the cellules of the mastoid process. Frequently it gives off a smaller fork or passage, which is directed outward and upward among the cellules above the external auditory meatus; and rarely a third branch is directed more anteriorly." (See Fig. 41.)

[1] "Petro-mastoid canal of Sappey."
[2] Corrosions-Anatomie.

"While the atrium of the tympanum varies but little in size, the attic and mastoid antrum vary greatly."

"The *mastoid cellules* consist of air cavities of variable number, size, and extent in the midst of the spongy substance of the mastoidea. They are commonly more or less pronounced in number and size with age. With the advance of years, they increase in both respects from the conversion of the ordinary marrow-filled, spongy substance into vacant spaces. Later, they increase in capacity by expansion and coalescence, and proportionately decrease in number; and often in old age some of them even exceed in size the antrum. The cellules communicate with one another and, through the sides and extremity, with



2/1

FIG. 42.—VIEW FROM WITHIN OF THE RIGHT TYMPANUM AND CONTIGUOUS PARTS (FROM HENLE). *Tt*, *Tt'*, tensor tympani; *Mcp*, head of the hammer; * handle of the same; *Ib*, short, *Il*, long process; *Ipl*, lenticular proces of the incus; *I*, chorda tympani; 2, septum tubæ; 3, tube; 4, drum-head.

the mastoid antrum." They are separated from the lateral sinus by a thin plate of bone only.

If now we carefully remove the *tegmen* in the recent subject, and look down upon the parts thus exposed to view, we shall find the attic and antrum *in situ*, and everywhere lined with mucous membrane. The attic is divided by the incus and malleus, which are placed across it fore and aft, into an outer and inner apartment; they only partially occupy it, and the long process of the former and the handle of the latter project down into the *atrium*. The two attic apartments, of which the inner is much the larger, communicate more or less freely with each other overhead, with the atrium below, the Eustachian tube in front, and the antrum behind.

The outer apartment is wedge-shaped, wider above and gradually becoming narrower below, where the body of the anvil and neck of the mallet lie almost in contact with the margin of the auditory plate. The bottom communicates anteriorly and posteriorly with the atrium by a very narrow slit.

The inner apartment communicates much more freely with the atrium, but the passage is contracted by the prominence before alluded to on its inner wall, the impingement of the anvil and mallet, the chorda tympani, ligaments, and folds of mucous membrane. (See Fig. 42.)

Anatomy of the Child's Ear.—At birth the tympanum and mastoid antrum, also the ossicula, are about as large as they ever become in adult life; the petro-squamosal suture is but imperfectly closed, its external portion being anchylosed only near the time of birth, and is usually not obliterated until the end of the first or second year of life. It is always well marked in infancy and often remains imperfectly closed throughout life.

"The mastoid process, scarcely marked at birth, becomes conspicuous only after a year or two. The mastoid antrum is developed at birth; but the surrounding mastoid cellules undergo but little development until after puberty."

"The external auditory meatus is produced after birth. The auditory plate forming its roof is gradually more differentiated from the rest of the squamosal, and its tympanic scute becomes more distinct by production of spongy substance between it and the roof of the meatus."[1] The tympanic orifice is formed by the smooth auditory plate above which constitutes about one-fourth of this bony circle and to which the superior border of the drum-head is attached; the lower three-fourths is formed by the *annulus tympanicus*—a distinct plate of bone at birth, but afterwards forming the *tympanic plate*.

The manner in which the drum-head attaches itself to this orifice is of great interest in connection with inflammation of the attic. Superiorly the membrana flaccida is loosely connected with the upper margin of the aperture (where the annulus tympanicus is wanting) over which it passes to become continuous with the lining of the upper wall of the external auditory canal; the entire surface of the auditory plate being smooth, this integument glides over it with considerable freedom. The membrana flaccida is much more distensible than the membrana vibrans, which latter portion of the drum-head is more firmly fixed into the grooved lower three-fourths of the circle.

[1] Quotations are from Leidy, loc. cit.

Under the pressure of retained fluids in the attic, the membrana flaccida and membranous wall of the adjacent canal are easily detached.

The auricle and canal of the infant are soft and flabby ; the former is not firmly fixed to the head and may be moved freely in all directions about its attachment ; the walls of the latter lie in contact, the superior wall being the longest. The canal and drum-head are covered at birth with smegma, the removal of which by wiping may also detach the superficial epithelial layer. Tension requisite to the performance of its functions does not yet exist in the transmitting mechanism, and hearing apparently is slight.

The horizontal plane of the drum-head at this period is favorable to the occurrence of injury from the mere gravitation of fluid in the drum, and when distention occurs in consequence of profuse secretion into the atrium it gives way readily.

The canal for the facial nerve lies like a ridge along the whole breadth of the inner wall of the tympanum just above the promontory ; this, and the margin of the auditory plate opposite, limits the passage between the *atrium tympanicum* and the *atticus tympanicus*. The boundary is further restricted by foldings of the mucous lining of the tympanum in adapting itself to the chorda tympani. In the normal state, drainage from the attic, as well as from the atrium, is afforded by the débouchure of the Eustachian tube anteriorly. The attic has a pretty free outlet into the atrium behind the descending ramus of the incus, since a hiatus exists between this ossicle and the posterior wall of the tympanum ; but the descent of the malleus handle and long process of the incus between these two outlets naturally encroaches upon the passage from the attic to the atrium.

CHAPTER XII.

OTITIS MEDIA NON-SUPPURATIVA.

Acuta ; Subacuta ; Serosa ; Chronica ; Syphilitica.

OTITIS MEDIA ACUTA.

Otitis media acuta is an inflammatory process of the mucous and submucous lining of the middle ear, having a very decided tendency to stop short of purulency. Thus a susceptible person may, after exposure to certain vicissitudes, take a severe cold in the head, as it is called, and after a few hours or days, as the case may be, a feeling of stuffiness in the ears with deafness and pain comes on ; sometimes one or the other of these symptoms is not severe. In the more pronounced cases, the trouble is ushered in with fever preceded by chills. The writer has often seen, on examining a case of this kind, a discharge emerging through a perforation in the drum-head of one ear, whilst inspection of the other drum-head only presented an inflamed condition, which, when observed from day to day, would be found to gradually clear up, the organ regaining its normal functions ; the latter is a case of acute otitis media. Sometimes one ear only is affected with acute inflammation ; but often both are invaded at the same time, or within a few hours or days of each other. A regressive course, where no causative influence remains active, begins in a short time and the trouble usually soon disappears. There are, however, important exceptions to this rule, especially in children, where recurrent exacerbations may ensue from time to time. In certain instances, the trouble passes into a subacute form which may continue a long time. Acute inflammation of the middle ear most frequently occurs in the course of a severe head cold, or from the reflected irritation in dental caries or dentition, rhinitis, the unskilful application of the cautery, acids, or the snare to the turbinated bones, and the like ; it is more particularly liable to inflammation from these influences during the existence of a head cold. The pain experienced is not always due to pent-up secretions, but may be reflected (otalgia), especially

in cases where the patient has dental trouble at the same time. Thus patients often apply for treatment on account of pain which they ascribe to the ear alone, and where, on examination, this organ will show no sign of inflammation, the seat of the disturbance being found in the teeth.

Etiology. As regards *age* and *causation*, children between the second month and the end of the second year are obnoxious to reflex irritation, due to first dentition, mal-nutrition, or dyscrasia, the exanthemata, and inflammation of the upper air-tract. Between the ages of four and fifteen years, the same causes are active ; second dentition giving rise to as much or even greater disturbance than first dentition, catarrhal affections continuing, with the greater frequency of hypertrophied tonsils. In childhood, furthermore, traumatism from blows on the ear, undue force exerted in the removal of foreign bodies from the organ, the entrance of sea-water into the ear in bathing, the use of the nasal douche, etc., is of occasional occurrence.

No account of the predisponents of this or any other aural trouble would be complete without allusion to the disturbances of the digestive and sexual functions, and the nervous exhaustion consequent on their abuse or perversion. Females subject to uterine disturbances are usually neurasthenic and consequently highly sensitive to vicissitudinous environments; as are also over-worked persons of both sexes, whose hygienic surroundings are bad. Putting aside the question of premature and exhaustive sexual activity in persons from puberty to adolescence, the writer finds that among his cases ranging from the sixteenth to the twenty-first years of life, phthisis, the result of exposure, frequently influenced the course of the disease and that sea-bathing was the exciting cause much more often than at an earlier age.[1]

From the age of twenty-three to thirty-five years inclusive, rhinitis, intemperance, abortion and other genital disturbances, the contamination of phthisis or syphilis, the irritation from the difficult eruption of wisdom teeth, caries of the teeth, etc.; the direct injury from sea-bathing, the use of the nasal douche, snuffing up salt water and other solutions; the unfavorable influences of mental worry and defective hygiene were all found to be important causative agencies.

Patients between the ages of thirty-six and forty-six years were influenced by similar causes. Among females, however, the menopause at this age exerts an unfavorable influence in certain cases.

[1] Causative agents, as over-work, crowding, sea-bathing, etc., of course apply more particularly to the inhabitants of large cities.

The following table gives the ages and sex of 384 cases of acute non-suppurative inflammation, from which the above etiological data were derived:

Age.	Males.	Females.	Total.
Under one year of age	2	2	4
Between 1 and 2 years	1	..	1
Between 2 and 3 years	1	2	3
Between 3 and 4 years	3	3	6
Between 4 and 5 years	4	3	7
Between 5 and 10 years	16	26	42
Between 10 and 20 years	59	20	79
Between 20 and 30 years	62	27	89
Between 30 and 40 years	46	18	64
Between 40 and 50 years	24	11	35
Between 50 and 60 years	9	4	13
Between 60 and 70 years	5	..	5
Total	232	116	348

The ages of the infants under one year were as follows: one 6 months (male); one 7 months (female); one 8 months (male), and one 9 months (female).

Objective Symptoms. The external auditory canal does not always show evidences of the presence of inflammatory action in the tympanum; but in the more severe cases of acute otitis media the dermic or periosteal layers of the canal may be involved by extension of the inflammatory process through continuity. The canal is, however, rarely so much swollen as to prevent an inspection of the drum-head. It is indeed but seldom that vascular disturbance about the ear does not also involve the mallear plexus, and an increased vascularity of this latter, together with congestion of the membrana flaccida, especially behind the malleus, are the most frequent changes observable. Where the inflammation is chiefly confined to the attic, the appearances just alluded to are, for the most part, very well marked, and under the pressure of secretions the membrana flaccida may bulge out. But where the atrium is the principal seat of the trouble, the membrana vibrans will also be found distended and very red, which appearance sometimes continues for days before regression is established. Blebs on the drum-head are not of uncommon occurrence.

When inflammation begins in the attic, the atrium is seldom greatly involved, and the reverse of this may hold good. Both attic and atrium are, however, frequently affected at the same time.

After a regressive course has been established, the drum-head often

undergoes a process of desquamation, its dermic layer becoming thus detached.

Subjective Symptoms and Course. The prominent subjective symptoms of acute inflammation of the middle ear are pain, often severe, deafness, noises in the ear (tinnitus), and autophonia (see Chapter XVI.); where the attic is principally affected, the degree of deafness is generally much less than where the atrium alone is the seat of the disturbance.

A feeling of "numbness" is a symptom often complained of by these patients, a phenomenon possibly due to the benumbing of the nerves about this region from the inflammation or the pressure of the swollen tissues. Such patients often say that they experience "dumbness," an autophonous phenomenon.

In uncomplicated, non-perforative (non-purulent?) inflammation of the middle ear tract, in which the mucous membrane of the tympanum (atrium and attic), mastoid antrum, and pneumatic cellules of the mastoid may all be more or less involved, recovery is, in healthy subjects, speedy, and but little, if any, deafness may remain. Even large quantities of mucous or setous matter are speedily reabsorbed. In run-down subjects, however, the mucous membrane is liable to remain thickened, or tough mucus may not be absorbed; in such cases defective hearing and tinnitus may be more or less permanent. In certain subjects infiltration of the tissues rapidly takes place, causing sudden and profound deafness from fixation of the ossicles, especially in syphilitic patients. The most marked non-syphilitic examples the writer has seen were in persons residing in the tropics. Two cases among the latter are particularly instructive.

Case 1.—A gentleman, aged 45 years, came to the writer in 1882 with the following history. He had resided in Rio, Brazil, some thirteen years altogether, having taken in the mean time two vacations of eighteen months each, during which he visited Europe and this country. During his residence in the tropics, he was for some time under severe mental strain, but passed the warm season in the mountains of Petropolis, the summer residence of the court, at an elevation of some three thousand feet. While so run down, the extreme and sudden variations in temperature were very trying; succeeding to intensely hot and dry days, were damp nights some 20° Fahrenheit cooler. Not having learned of the perils of *el sereno*, the fatal night air, he was less prudent, in respect to exposure after sundown, than the natives (who are careful to protect themselves with warmer clothing, and avoid uncovering the head needlessly for a moment even), and finally contracted severe head catarrh. There was, at first, a sense of great heat and discomfort in the nose, perversion of the sense of smell, especially on rising in the morning, when

everything had the odor of "burnt meat." There was soon a profuse down-pour of fluid from the head, mixed with blood. On the frontal sinuses and other cavities becoming invaded, the head felt "hot and dry." These symptoms continued for some time. The ears were early involved, and as the disease progressed he became *rapidly very deaf*. Distressing tinnitus accompanied the other symptoms. He was for a few days so deaf as to be unable to converse, but before long some improvement took place; there was no marked improvement in the head catarrh, however, until he left the tropics; and when seen subsequently, he could converse with difficulty, in an ordinary tone of voice, at a distance of six or eight feet. Under the more favorable influences of the climate in New York, he improved very much under treatment.

The next case is similar to the above.

CASE 2.—An English gentleman, 35 years of age, residing in Venezuela. This patient, a person very much over-worked, in April, 1884, made a three weeks' journey into the interior of the country, during which he was much exposed to an almost continuous rain-storm. He escaped the prevailing fever as he had done hitherto, during twelve years' residence in tropical South America. During his stay with a friend in the country, he sat one morning after breakfast in the corridor or the house without any coat. After dinner, the same day, while engaged in conversation, he *suddenly* had a most profuse flow of fluid from both nostrils and the eyes, which lasted for some hours. The attack was severe and was accompanied with much coughing. It was feared that this would prove to be a precursor of the "fever" of the country, but the more disagreeable symptoms passed off by the next monring. Head catarrh, however, continued, the tympanum became affected, and there was almost total deafness. A disagreeable sense of fulness in the head, and dryness of the upper air-tract, characterized the course of the disease and, in fact, still remained when the writer was consulted.

Treatment. The treatment of otitis media acuta, or non-perforative inflammation of the middle ear, includes remedies for the relief of earache, which is, especially in children, a prominent symptom. Since the more serious cases usually occur from neglect or meddlesome treatment in subjects run down from some cause or other, fixed rules for guidance in any particular instance cannot be laid down. Each case must, to a great extent, be regarded as an individual problem requiring special consideration.

The administration of minute doses of mercury is reputed to exercise a beneficial influence in inflammation of mucous surfaces, and, since the subjects of mucous catarrh are liable to have gastric derangements at the same time, the practice seems well founded. The writer often employs some form of the drug in trituration tablet form,

in doses of $\frac{1}{20}$ to $\frac{1}{60}$ of a grain every three or four hours, according to circumstances.

In some instances, the calx sulphurata administered in the same manner seems to give good results. Vascular and nervous excitement, usually attended with more or less pain and swelling about the ear, may be controlled by aconite, belladonna, gelsemium, pulsatilla and other drugs of similar action. Unendurable pain calls for the administration of decided but tentative doses of morphine.

In certain cases much relief may be obtained, or even a cure may result, by removing the secretions from the tympanum through the Eustachian tube, a successful case of which, previously reported,[1] is given herewith.

CASE 3.—The case was that of Prof. J. C. Bryant, who at the time was much run down with overwork. He had contracted a severe head cold and was taken with consecutive acute otitis media on January 29th, 1884. Both ears were affected in the beginning, there being present much tinnitus and autophonia, which symptoms increased the following day to a very great extent. There was, furthermore, vertigo with nausea, occasional unsteadiness of gait, and a very considerable impairment of the hearing power. The phenomenon of staggering was notable, the patient experiencing concussion of the brain and confusion of ideas from the sound of his own voice. On the 31st inst. the trouble began to concentrate, as it seemed, in the right ear, which was now the seat of so much pain that he came to consult the writer about it.

Appearance of the ears.—The left membrana tympani was slightly hyperæmic about the short process of the malleus, but was otherwise free from inflammation. The right membrane had the general appearance of being intensely inflamed, but on close inspection the inflammation was found to be confined to the membrana flaccida for the most part; indeed, the posterior part of this structure was greatly distended, and was bulging out as though it would burst. The contiguous dermic layer lining the superior-posterior wall of the canal was, for the distance of some lines, elevated and very red. The intumescence also extended somewhat downwards along the posterior margin of the membrana tympani, being sharply limited anteriorly at the malleus handle. The swollen membrana flaccida overhung the comparatively unaffected inferior segment of the membrana tympani, thus giving the appearance of much more general distention than actually existed.[2] This case, it will thus be seen, was one of acute catarrhal inflammation of the attic.

[1] The Lancet, October 18th, 1884.

[2] The overhanging intumescence above alluded to, and entirely concealing the rest of the membrane in certain cases, is most puzzling to the observer when the true nature of the disease is not recognized, and it is in such cases that disappointment is liable to be experienced in consequence of the escape

On being asked by the patient who was seeking relief, if the confined secretions might not be drawn out through the Eustachian tube, it occurred to the writer that the operation could be successfully performed by means of the flexible Eustachian catheter[1] which he introduced some years ago. A catheter of one-fourth of an inch in diameter was introduced through the inferior nasal passage, and, after connecting it with a large metallic ear syringe by means of a stout piece of soft rubber tubing ten inches in length, suction was effectually established by using the syringe as in aspiration. It was worked by one hand whilst the other hand kept the catheter in place. By means of an otoscopic tube, the suction in the affected ear could be plainly heard by the author with each pumping stroke of the piston, the action being yet more plainly manifest to the patient, who, after one or two successful exhaustive efforts had been made, exclaimed, "That does the work; the pain has gone." Suction was then maintained until half a dozen strokes of the piston were made. Relief from the disagreeable tension and other symptoms was not only immediate but also permanent, although the deafness, autophonia, etc., did not disappear entirely for some days. Examination showed the bulging and congestion of the membrana flaccida much reduced and diminished.

In the previous attacks of acute inflammation of the middle ear, to which the same gentleman had been subject, purulency had frequently occurred, the drum-heads rupturing spontaneously or being punctured. Suppurative action was probably prevented in the present instance by the timely withdrawal of the secretions from the tympanum. Under an after-treatment consisting of small doses of calx sulphurata, aconite, and belladonna, the recovery was uninterrupted and complete.

For slight redness of the membrana flaccida, in the regressive course, local treatment is inadvisable. Where there is periostitis of the canal, incisions often do harm, but when secretions in the drum accumulate, the symptoms may become urgent and the employment of the knife demanded. Vent to secretions in the attic may generally be assured by introducing the myringotome, or better the knife described and figured in Chapter XIII., through the upper edge of the

of air only when the membrana tympani is punctured, the pent-up secretions being confined to the upper chamber.

[1] This catheter, it may be well to state here, is made of flexible rubber, but is sufficiently unyielding to retain its shape while in use. It has a soft, velvety finish, and its introduction in the adult creates so little discomfort that one which is one-fourth of an inch in diameter can generally be employed. This is readily introduced into the mouth of the Eustachian tube, and permits a large current of air to pass.

Vide Trans. Am. Otological Society, 1881. The catheters are made by Mr. Ford, of Hazard, Hazard & Co.

membrana tympani and behind the long process of the incus. Since there is some danger of wounding the chorda tympani nerve in this operation, the surgeon should not carry the point of the knife too high up.

No plan of treatment would be satisfactory where the mouth or upper pharynx was neglected.

Under treatment, the worst agonies of acute otitis media may be prevented, and very often our remedies act like a charm; but it must not be forgotten that the causes in a given case may not be so easily eradicated, and that treatment must be kept up for some time if we would entirely prevent a return of this tormenting disease.

The advantages of rest, both mental and physical, keeping the head in repose, in acute inflammation of the middle ear, should never be lost sight of, and the patient should be kept indoors for several days. If the case be a severe one, he will be better off in bed for a time. Quiet ought to be maintained in all cases, for noises under these circumstances are sometimes exceedingly distressing. The application of moderate dry heat for pain, when grateful to the patient, is advisable. Much relief does not follow the instillation of anodynes, which only come in contact with the dermic surface; we are thus unable to avail ourselves of cocaine, and the like, in these cases. Dry air or vapor blown into the ear often gives relief, however; the employment of the vapor of chloroform sometimes relieves an earache in the manner, but, as with cocaine, its action when applied to dermic tissues is slight.

Of course, a rigid dietary should be enforced, and personal and general hygiene attended to, especially in respect to overheating. The evils of active treatment in these cases, by syringing, etc., should be borne in mind, and it may be here urged that deafness as a symptom should not be treated.

Should inflation of the tympanum, either by the air-bag or by the Valsalvan method, be now accomplished, the forcible entrance of air may not be only painful, but also harmful. These procedures, often employed to improve the hearing in chronic cases, are of doubtful value in acute inflammation of the middle ear. At a later stage of the attack, we may, of course, avail ourselves of these pneumatic methods.

The possible relief attained from the depletion, due to the application of leeches, may be more than counterbalanced by the irritation of their sharp bite and the bungling attempts made in stopping the bleeding after they drop off; the large coagula entangled in pellets of cotton-wool, used to arrest hemorrhage, are also liable to irritate the

parts, especially in children. Blistering and painting with the tincture of iodine over the mastoid, or in front of the ear, are generally useless procedures, and are not always harmless.

The well-known tendency of some drugs to cause or increase existing aural symptoms should warn us to beware of their indiscriminate use. First among these is quinine, long suspected of causing deafness when administered in large doses. The intense tinnitus aurium following its administration is significant. The employment of ferruginous preparations seems, in some cases, to have a like effect, and, doubtless, there are many others which it were best to omit when the ear is acutely inflamed. During the existence of acute aural disease, the consequences of its early management upon the subsequent course and duration should be kept in mind.

The following cases, selected from the records of a large number treated, are given as typical examples of the tendency of the inflammatory process, in many instances, to stop short of perforation of the drum-head; they illustrate, furthermore, the good results attained by a non-meddlesome course of treatment.

CASE 4.—*Inflammation of the atticus tympanicus; symptoms due to blowing the nose. Catarrh of the upper air-tract. Decayed teeth giving rise to reflected neuralgia. Recovery in three days.*

Patient, male, aged 53, tailor; "has head catarrh and is deaf in both ears." He has had frequent attacks of ear catarrh with pain. After blowing his nose forcibly yesterday he experienced sudden pain in the right ear, followed by tinnitus and some increased hardness of hearing. He slept well, however, and there has been no discharge from the ear. On examination of right ear, the membrana flaccida, posterior fold, and parts about short process are found hyperæmic. A number of vessels of the manubrial plexus are injected, their course being traced by delicate, fine thread-like lines, giving the whole an arborescent appearance. The membrana tympani of the left ear is lustreless, humid, and somewhat retracted, with marked opacity in the posterior-inferior segment. Patient hears ordinary voice only in both ears. There is catarrh of the upper air-passages. The teeth are in a carious condition, a few old shells remaining.

Aconite and belladonna were administered in small doses, repeated often. Patient next seen three days later, when it was found that the vascularity had subsided, as had also the subjective symptoms.

CASE 5.—*Acute inflammation of the atticus tympanicus and atrium after sea-bathing. Recovery in six days.*

Male, aged 15. There is no history of previous ear trouble. Patient went in bathing twenty-four hours ago, diving frequently. He does not remember having snuffed up any water into his nose or mouth. A few hours afterwards he was seized with tinnitus and pain in the left ear, the latter being so severe as to entirely prevent sleep. There

were also autophonous phenomena present, but no discharge. On examination of left ear, the membrana flaccida is found fleshy in appearance, partially detached, and bulging considerably. The membrana vibrans is uniformly hyperæmic and denuded, the surface being puckered and swollen. The right ear is unaffected. Hearing in right ear, normal; in left, ordinary voice only is distinguished.

Patient was treated with calx sulph., gr. $\frac{1}{60}$ every two hours, aconite and belladonna being given for the pain. The following day patient returned, stating that after taking three doses of the aconite and belladonna the pain had subsided, and that he had slept well for the first time in forty-eight hours. The membrana tympani presents no change in its condition. During the following forty-eight hours patient had some pain in the daytime, but rested well at night after taking a few doses of the aconite and belladonna. On the sixth day, the membrana vibrans and membrana flaccida were found, on examination, to be clearing up. The pain had subsided, and patient experienced no further trouble.

CASE 6.—*Acute inflammation of atrium. Catarrh of upper air-tract. Decayed teeth. Spontaneous recovery.*

Female, aged 10. Patient has long suffered from frequent attacks of otalgia in the right ear, not accompanied by tinnitus, deafness, or discharge. After "taking cold" one week since, severe pain and tinnitus appeared in the right ear, continuing without intermission until the present time, and preventing sleep. No discharge, however, was noticed. On examination of right ear, the membrana tympani is found desquamating, bulging, and the landmarks are not visible. There is a crust of exfoliated epithelium lying in front of the drum-head. The membrana tympani of the left ear is somewhat clouded in its posterior segment, the anterior segment being brilliant in appearance. Hearing, right ear, loud voice; left ear, low voice; at ten feet distance.

The posterior wall of the pharynx is covered with adenoid vegetations, and the tonsils are hypertrophied. Several shells of carious teeth retained in the upper and lower jaws, and an abundant accumulation of tartar, causing reflex irritation in the ear, would seem to account for the tendency to recurrent attacks of aural catarrh. She had the carious teeth removed. Four days later, when again seen, the exacerbation had subsided without having taken any medicine.

CASE 7.—*Acute inflammation of the atrium after sea-bathing. Exudation cyst of the drum-head. Chronic catarrh of the upper air-tract. Cured in seven days.*

Male, aged 17, epileptic. Patient is subject to frequent attacks of toothache and pain in the ears. Bathes very frequently in summer, and indulges a good deal in diving and sporting in the water of the sea. During his last bath, two and a half weeks before coming, he got "water in his right ear, and has not been able to get it out" (by the usual method of hopping on one foot). There has been some tinnitus aurium and sensations of "gurgling, snapping, and sounds of

bubbles" in the ear. No autophonous voice, deafness, or discharge. During past twenty-four hours, some pain in right ear.

Examination of right ear. A large, oval, cyst-like swelling occupies the whole of the posterior segment of the membrana tympani. The surface has a dermic, lustrous appearance. Only a portion of the anterior quadrant can be seen. Left ear normal. Hearing, low voice in both ears.

In twenty-four hours pain subsided under the administration of aconite and belladonna. As the symptoms were not of an aggravated type, and as the cyst was not increasing in size, incision was delayed. On examination, forty-eight hours afterwards, the vesicle on the drum-head had disappeared, leaving the dermic tissue of the latter puckered in appearance. Aconite and belladonna discontinued. On the seventh day the subjective symptoms had subsided; the drum-head was seen on examination to be resuming its normal appearance. Patient discharged cured.

CASE 8.—*Acute inflammation of atrium and attic. Odontalgia. Recovery in ten days.*

Female, aged 40. No previous ear trouble. Two weeks ago, after exposure and wetting of feet, contracted an acute catarrh of the upper air-passages. In forty-eight hours was taken with pain in right ear accompanied by deafness and autophonia. The pain has increased in severity, and is aggravated by coughing, sneezing, and by exposure of person to cold air. During the past week all the teeth in both upper and lower jaws, right side, have been painful. Patient has noticed no discharge. General malaise and anorexia.

Examination of right ear shows the drum-head and adjacent walls of canal to be denuded and intensely injected. The flaccid membrane is bulging slightly. Landmarks not seen. No perforation detected. The left drum-head shows evidence of trophic changes. Hears loud voice in right ear, low voice in left. Pharynx is congested. Right lower sixth year molar is pulpless, and there is inflammation of the gums and accumulations of tartar on the teeth.

Patient was given calx sulph. (gr. $\frac{1}{20}$ every three hours), and was sent to dentist to have molar tooth extracted. In twenty-four hours there was decided amelioration of pain. The inflamed parts, however, were still hyperæmic, and the bulging of flaccid membrane had not increased. During the next six days, there was gradual subsidence of subjective symptoms, and treatment was discontinued on the seventh day. On the tenth day after admission, the drum-head was clearing up, low voice was heard in the affected ear, and patient had no further trouble.

CASE 9.—*Acute inflammation of attic and congestion of membrana flaccida. Atrium and membrana vibrans not involved.*

Male, aged 23. Three years ago had earache in right ear, without discharge. "Takes cold easily." Three days ago was taken with pain in the left ear, aggravated by coughing, mastication, sneezing, etc., and by pulling on the auricle. He has noticed autophonia and deafness, but no discharge. Sleeps well.

Examination of the left ear shows the membrana flaccida and superior adjacent wall of canal to be injected; the membrana vibrans is normal in appearance. Some ten minutes after first examination, a second examination was made (the patient having complained of more pain), when a very marked increase in the intensity of the congestion was observed. The right ear was normal. Patient heard low voice in the left ear, lowest voice in the right. Calx sulph. ($\frac{1}{60}$ of a grain) administered every two hours, and aconite and belladonna every fifteen minutes, resulted in relief.

Of course, the experienced observer will nearly always be able to judge from the constitution of the patient, and the progress the disease has already made, as to its probable severity. Some of the cases above reported very well illustrate the effects of the rapid effusion which sometimes takes place in the attic, especially in the early stage of inflammation, in consequence of which there is detachment of the dermic layer of both drum-head and canal walls immediately in front of this region, with more or less tumefaction. The early recognition of acute otitis media is important, especially where the attic is chiefly involved.

These cases are noteworthy on account of the absence of perforations in the drum-head, and consequently of otorrhœa. The vibrating portion of the drum-head being unaffected, there was but little deafness, and there was no autophonia. In a certain number of these cases, there would doubtless have been a rupture of the drum-head but for the escape of fluids via the Eustachian tube. The exudation cyst described in Case 7 was not large and did not, therefore, prevent a diagnosis being readily made; when these cyts are large, involving the greater portion of the drum-head, the appearances are misleading, even to an expert, since all of the natural landmarks are obliterated. It will be observed that in Case 9 the careful introduction of a speculum for the inspection of the deeper parts was followed by an increase of hyperæmia and pain; attempts at establishing a complete diagnosis by prolonged examination, and the thorough removal of epithelial products and the like from the ear, are therefore often inadvisable, since these procedures are liable to injure the inflamed parts.

Too much stress cannot be laid on the advantages of letting well alone, persevering and fussy local manipulations nearly always doing harm.

OTITIS MEDIA SUBACUTA.

This is often a sequence of otitis media acuta, but in a considerable number of subjects seen by the writer the trouble seemed to have begun as a subacute process. In many instances, however, it appeared in cases affected with chronic inflammation of the middle ear. We find it occasionally arising in an organ in which the results of chronic purulent inflammation remain, such as thickening, adhesions, opacities, perforations, and the like. It may result from sniffing up solutions of various kinds, the use of irritating snuff, sea bathing, the presence of foreign bodies, and the like.

In 84 cases taken from the author's records, 55 were males and 29 females. Their ages were as follows:

Between 1 and 3 years	5	cases.
" 3 and 11 "	15	"
" 11 and 21 "	16	"
" 21 and 31 "	22	"
" 31 and 41 "	14	"
" 41 and 51 "	8	"
" 51 and 61 "	2	"
Over 61 years	2	"
Total	84	"

In 31 of these, severe head colds, ozæna, rhinitis, and naso-pharyngeal affections generally were noted as prominent causative influences. In 45 of the cases, dentition in some stage, caries of the teeth, and other oral irritation, was present. The presence of a wisdom tooth erupting with difficulty, or a tooth on the same side filled after destruction of the pulp, was seen in several instances to keep up the aural trouble. Subacute inflammation was observed to be a sequence of measles, pertussis, and syphilis in a number of instances; and in one case exposure to compressed air in a caisson of the Hudson River Tunnel. Eczema and a rheumic diathesis existed in several instances, standing in a causative relation to the trouble.

In a few cases the process began in the attic, and in several there was hyperæmia or dermatitis of the adjacent walls of the external auditory canal.

Objective Symptoms. The appearances of the drum-head were always characteristic, the same being red and dry. This dry appearance is a very, if not the most, prominent feature of the tympanic membrane in chronic subacute otitis media; in one case only was a decided collection of secretions in the drum noted.

In a large number of instances, the drum-head was greatly retracted, being sometimes indistinguishable from the inner wall of the canal but for the prominence of the short process; when thickening of the parts about the upper segment was great, even this could not be well seen. The drum-head remains intensely red in some cases for an almost indefinite period, owing to the persistency of exciting causes, or frequent recurrences of head colds; this is especially the case with children.

Subjective Symptoms and Course. In a number of cases, distressing noises in the ears were noted, and likewise autophonia, causing even greater discomfort. Symptoms of vertigo were marked in some cases, and in quite a number there was extreme nervousness and neurasthenia. One person was the subject of delusions and other alarming phenomena. Deafness was extreme in nine cases, three of whom were totally deaf, the origin of which was claimed to have been meningitis. In four individuals, the development of the trouble had been rapid, the accompanying deafness sudden and great.

In but one of the author's cases was the hearing unaffected. Headache, neuralgia about the ear, otalgia sometimes lasting for weeks, and other nervous phenomena were observed to a greater or less degree in a very considerable number. Deafness was, however, the most frequent cause of complaint, school children being brought especially on account of this symptom.

The *course* of subacute inflammation tends decidedly toward chronicity; it may continue for months or years. On the other hand, however, it may be kindled up into an acute purulent process. The retraction of the drum-head is probably due, in the greater number of cases, to closure of the Eustachian tube, either at its pharyngeal or tympanic orifice.

These cases of subacute otitis media are often quite intractable, owing to the unfavorable condition of the patient as regards susceptibility to colds and dental irritation.

Prognosis. Under these circumstances, the prognosis not always favorable, since the hygienic conditions are beyond the physician's control, and, moreover, the deformity of the transmitting mechanism, due to great retraction of the drum-head in protracted cases, becomes finally irremediable.

Treatment. As regards prophylaxis and hygiene, the treatment is similar to that mentioned in the management of acute inflammation of the middle ear. Inflation of the drum by Politzer's method is advantageous and may be practised daily for a time; on improvement taking place, however, it should be done less frequently. In adults

the ear may be inflated to advantage in some instances by means of the Eustachian catheter.

OTITIS MEDIA SEROSA.

So far as is known to the writer, this form of middle ear disease is not mentioned in the older works on the ear; later writers, however, such as Burnett, Barr, Schwartze, and others have described it.

The pathogenesis and etiology of the serous form of middle ear inflammation is similar in many respects to that of subacute inflammation of this region. It arises, however, nearly always in subjects having a well pronounced rheumatic or gouty diathesis. The occurrence of this trouble is doubtless much more frequent than the small number of cases seen by the writer would seem to indicate, since in all of these the external auditory canal was unusually large, affording a good view of the fundus. It is, therefore, probable, that many cases escape observation where the canal is small.

This affection is essentially one of advanced life; the author at least has never seen a case in childhood. Of twenty-five cases of which notes were taken, sixteen were males and nine females. The youngest patient was fifteen years of age, the oldest sixty-seven. Nine were between twenty and thirty, eight between thirty and forty, six between forty and fifty years of age.

Objective Symptoms. The drum-head may or may not be much inflamed. In several instances where the attack followed the entrance of sea water in bathing, there was, at first, considerable myringitis present; and where the trouble first manifested itself principally in the attic, there was some tendency to the formation of an abscess from the burrowing of fluids along the upper and posterior walls of the canal. The canal is sometimes hyperæmic at its inner extremity; in one case seen, there was a desquamative process going on. Generally, however, the drum-head was found relaxed and more or less macerated in appearance, with sufficient translucency to admit of the serous contents of the drum being seen. The collection of fluid, being for the most part confined to the atrium, is easily seen. On first looking into the ear, the observer is liable to mistake the surface line of the fluid contained in the drum for a hair lying horizontally across the drum-head; the writer well recalls how he was first misled in this manner. The Valsalvan experiment affords an instructive picture of the fundus; the air thus forced into the drum fills the cavity more or less with bubbles which range themselves on the inner surface of the drum-head and are thus plainly visible. The

fluid, moreover, alters its position with every change of the patient's head—the hair-like line mentioned above showing, of course, the surface of the fluid. The drum-head, as just stated, is nearly always relaxed, its loss of tension being observable if the ear be viewed during the Valsalvan experiment.

Subjective Symptoms and Course. The invasion usually manifests itself during a severe cold in the head, the local symptoms, though sometimes of an acute nature, never exhibiting a tendency toward suppuration. In the greater number of instances, however, the trouble began as a subacute inflammation; in two instances, there was also acute myringitis present.

Pain in the ear is not usually present, though in one case of the acute form it was severe for a short time, whilst in another instance it was decidedly annoying. Where dead teeth were found, some neuralgia generally existed.

Most of the patients were greatly alarmed at the symptoms, and came more on account of the autophonia, sensation of "numbness" about the ear, and nervousness, than in consequence of pains or deafness. Among women at the menopause, the neuropathic condition was, in several instances, extreme and gave rise to distressing apprehensions on the part of the patients themselves.

Autophonia existed in nearly every case; in several individuals vertigo was present, "creeping" sensations in the ears, etc. One patient, a lady, experienced, on stooping over, a sensation of the drum-head "flopping down," as she expressed it; on elevating the head it "went back."

The comparatively small amount of deafness in these cases is probably due to the slight interference offered by the serous fluid in the drum to the action of the transmitting mechanism; the modification of the drum's resonance, owing to the pressure of the fluid and the relaxed condition of the drum-head, serves to explain the autophonous phenomena.

The course of this disease is generally very slow, continuing, in most instances, for weeks and months. The patient is liable to a return of the trouble with every recurrence of head cold; a cure, however, may be promised in most cases.

Treatment. The treatment should, in a general way, be directed to the diathetic trouble, and here we may avail ourselves of the experience of the regular family medical attendant. Locally the nasopharynx should attract our attention, and an occasional inflation by means of Politzer's method will be found beneficial.

Pressure upon the drum-head by the rarefaction of air in the exter-

nal auditory canal will, in some instances, be of service in expelling the fluid via the Eustachian tube. We must, in these cases, however, rely mainly upon absorption ; this is not a rapid process in run-down persons past the meridian of life.

OTITIS MEDIA CHRONICA.

Chronic catarrh of the middle ear. As far as the pathogenesis is concerned, inflammatory affections of the upper air-tract should be considered as a whole, although the ear, olfactory region, and, in a lesser degree, the various cavities and sinuses of the head, may become specially affected at times, one more so than the other.

By far the greater number of aural affections coming to the notice of the otologist are of this nature. The disorders of the mucous membrane of the middle-ear tract under consideration comprise the more or less protracted vaso-motor or sensory disturbances affecting its secretion and nutrition. The aural reflex neuroses concerned may owe their origin to nervous irritation propagated from numerous sources, as the brain, stomach, naso-pharynx, teeth, genital organs, etc. Mental impressions are well known to exert an important influence on the secretion of the upper air-tract ; thus under the influence of grief we find, in persons of a susceptible nature, that lachrymal and nasal secretions are freely poured out, and that such persons are extremely liable to head colds. This example of profuse secretion serves to point out the manner in which both secretion and nutrition may be influenced by long-continued mental strain and worry. The writer has seen numerous instances among professional and business men of New York, where overwork has been followed by disease of the outer or middle ear, long before symptoms of a general breaking down of the system manifested themselves in other ways. In a like manner, the ear is affected by influence from other regions of the body; these have been discussed elsewhere (see Causes of Ear Disease, Part II. of this work).

The pathological changes produced by this disease are similar to those taking place under like conditions in other mucous surfaces. We shall find that in hypertrophic inflammation the mucous membrane becomes thickened from the proliferation of tissue ; the Eustachian tubes becoming more or less obstructed, preventing intra-tympanic air-renewal, as shown by the retracted drum-head, which, under the exterior air-p[illegible]ept in a more or less hyperæmic condition. This ret[illegible]m-head may continue for

a long time, depending somewhat on the age and condition of the patient. It is particularly a disease of childhood and youth. Sooner or later, however, under long continued reflex hyperæmia, atrophic changes take place in the mucous membrane, and where the Eustachian tubes remain long closed, the effect of pressure upon the exterior of the drum-head is shown, especially where acute or subacute inflammation has intervened. The behavior of secretions under these pathological changes in the mucous membrane has probably much to do with the interference in the movements of the transmitting mechanism; the character and quantity of these secretions is modified by the nature of the inflammation, being mucous, serous, etc.

Etiology. An analysis of 1,791 cases of chronic otitis media, of which the author kept notes, gives some points of interest in this connection. The ages and sex of these patients were as follows:

Age.	Males.	Females.	Total.
Under 5 years	17	8	25
Between 5 and 10 years	32	44	76
Between 10 and 20 "	137	146	283
Between 20 and 30 "	252	222	474
Between 30 and 40 "	200	152	352
Between 40 and 50 "	157	126	283
Over 50 years	182	116	298
Total	977	814	1,791

In a considerable number, where it was claimed that an hereditary tendency existed, it was found that a number of persons in the same family were, from similarity of constitution and manner of living, specially susceptible to causative influences. There were over 100 cases where an aggravation of the trouble could be traced directly to syphilitic infection, and it seems probable that in many others where syphilis was denied, or the patients were ignorant of its existence in themselves or parents, its influence on general health was felt. In 31 cases, decidedly intemperate habits were noted, and in a considerable number this and dissolute living, etc., undoubtedly induced or greatly exaggerated the condition of the organ and consequent deafness and other symptoms. In 114 of the female patients, irregular menses, pregnancy, childbirth, uterine troubles, etc., seemed to exercise a decidedly untoward influence.

Of these cases, 74 were at the same time affected in one ear with acute purulent inflammation, and 112 with chronic purulent inflammation of the middle ear. In 221 cases there was impacted cerumen, and in 15 cases seborrhœa.

There was marked inflammation of the upper air-passages, including cases of hypertrophied tonsils in 900 cases. Oral irritation due to caries, eruption of teeth, etc., was present in 882 cases, and in 116 cases of these latter, vulcanite and other ill-fitting and unhealthful dental plates were found to be worn.

The size and curvature of the external auditory canals, in numerous instances, showed great variations; in 312 cases they were unusually large, some of them being of enormous size. In a few instances the canals were very small. From such facts the inference might be drawn that in some way persons with unusually large canals are more susceptible to certain causative influences. In 448 cases degenerative changes were found in the drum-head, whilst in 99 instances a marked deformity gave evidence of imperfect development.

In advanced life, and often at an earlier period, where a general breaking down of the system is manifest, we sometimes discover such a state of things in the defective condition of the drum of the ear and its mechanism before other symptoms attract special attention, since there are generally very distressing aural symptoms, as noises in the head or ear, autophonia, deafness, and sometimes vertigo. In consumptives and subjects of albuminuria or diabetes mellitus, a relaxed drum-head and tendency to serous or suppurative action manifest themselves for a long time before assuming an active form.

Objective Symptoms. The appearances of the drum-head in this disease are generally characteristic; thus, in some instances it will usually be found more or less opaque and thickened. Sometimes opacities in various forms, sizes, mostly semi-lunar in shape, gradually make their appearace, most frequently upon the posterior segment. This tendency to trophic changes on the posterior aspect has doubtless some significance; it indicates probably the greater influence of the nervous supply of this region. Very often the entire drum-head presents a uniform, porcelain-like, whitish appearance, the surface having a dry, glazed look.

In other instances the membrane assumes a thin, often humid and translucent appearance at first, which in many cases then gradually changes to a dry, parchment-like condition. Sometimes the disappearance of connective tissue will bring into view the radiating and circular fibres of the drum-head; and where acute purulent inflammation has intervened, various changes in the appearance of the parts may be found. Sclerosis of the membrane is a sequence of the pathological processes described.

In some cases, however, the drum-head remains thin and translu-

cent, so that the inner wall of the drum and the long process of the incus and the stapes are plainly visible through it.

In sclerosis which is so liable to be attended with great deafness, but slight changes may be observed in the appearance of the drum-head, its normal brilliancy remaining almost unchanged in many cases.

It is not to be supposed, however, that the otologist will always be able to determine the exact condition of the drum from the appearances above described in the drum-head, since these are not always by any means well defined, and, moreover, each variety is liable to become modified from various causes, as, for instance, the general condition of the patient, intercurrent exacerbations of acute purulent or non-purulent inflammation; thus the parts are often thickened or marked by cicatricial reproductions either thin or opaque.

Subjective Symptoms and Course. Chronic non-suppurative (catarrhal) inflammation of the middle-ear occurs at any time after birth, often as the sequence of acute or subacute inflammation of this region. Though a very inconsiderable amount of deafness will prevent a child from learning to talk, this symptom is frequently not observed until the infant is several months old; indeed, the writer has observed instances where one or two years had already elapsed before a conviction of the child's dumbness forced on the parents the knowledge of its deafness. This subject will, however, be treated of elsewhere (Chapter XVIII.)

Usually the advance of the trouble under consideration is gradual; its very existence may not be discovered until very considerable deafness has occurred. Generally the disease goes gradually on until some acute or subacute exacerbation from "colds" produces a rapid increase of deafness from pathological changes in the transmitting mechanism of the ear. One ear, usually the left, is found to be first affected, and in the end most impaired.

Exacerbations occur in susceptible persons very frequently from exposure to vicissitudes which give rise to colds. The occurrence of "catarrh" in the ear alone is rare; it generally affects the entire upper air-tract almost simultaneously, though from the well-known metastatic nature of mucous membrane inflammation it may almost entirely disappear from one locality of the general air-tract to immediately show itself in some other. We must not suppose, therefore, that where bronchitis exists one day, a rhinitis the next, and an otitis the day following, the inflammation travels along the mucous tract by continuity in all cases.

Deafness, as before stated, usually comes on gradually, but acute or subacute inflammatory exacerbations, especially the latter, causing

either proliferation of connective tissue about the articular surfaces, membranous exudation, or the secretion of tough mucus, greatly increase the defects in the hearing power.

These processes are all of them often more or less sudden, and the consequent deafness more or less permanent. The hearing of the deaf is generally worse after mental strain, or exhaustion from any cause; this is, moreover, retro-active, since the consciousness of their own defectiveness in this respect serves to increase the mental depression usually present among this class of patients.

The normal quantity of mucus secreted in the drum is small, and probably disappears almost entirely by means of evaporation, along with the air which ventilates the organ; but the abnormal secretions mentioned cannot escape in this manner, having to find their way out through the Eustachian tube or be absorbed.

Whilst healthy persons are less susceptible to, and quickly recover from attacks of acute catarrh of the middle ear, the disease is, in run down, decrepit, and cachectic subjects, more liable to go on to chronicity with consequent deafness.

For an account of other important subjective symptoms occurring in the disease under consideration, such as noises in the ear, autophonia, aural hallucinations, etc., the reader is referred to the detailed account of the anomalies of audition treated of in Chapter XVI. Vertigo and various reflex phenomena occur in the course of many extreme cases.

As regards the symptoms occurring among the 1,791 cases enumerated above, neuralgia was experienced in 90, distressing noises in the ears in 430, autophonia in 207, vertigo in 138, and otalgia in 36 cases. Anomalies of audition, such as dysacousma, aural hallucinations, better hearing in a noise, etc., were very marked in 86 cases, though present in some degree in a much larger number.

A large number of patients give but little heed to a moderate amount of deafness, especially so long as the hearing of one ear remains fairly good. Persons are much more likely to apply for relief when noises in the ear exist, or other subjective symptoms usually accompanying chronic otitis media; or they are induced to seek relief when their occupation is interfered with by the deafness.

Diagnosis. The diagnosis of chronic non-suppurative inflammation of the middle ear will not be difficult from what has already been said. In cases of extreme deafness, however, the question will sometimes arise as to whether the auditory nerve or auditory perception tract are involved. This question has an important bearing in the case of

deaf children, and has been discussed in that connection (Chapter XVIII.).

In the extreme deafness of chronic inflammation with which we have to deal in this connection, where, as a general thing, the defectiveness of the hearing power has advanced gradually, the nerve probably suffers deterioration from disuse and also from age; besides, the perceptive centre declines in power along with other mental functions. So long as subjective phenomena, such as noises in the head, autophonia, etc., exist, we may conclude that nervous sound transmission goes on. When these are no longer experienced, and the patient cannot hear his own voice, it must be inferred that defectiveness of the inner ear exists.

Some writers recommend the use of a tuning fork placed, while vibrating, upon the teeth, vertex, glabella, or mastoid process, in order to determine the transmissibility of sound irrespective of the conductive mechanism of the middle ear; but the patient's ability to estimate the value of this experiment varies greatly, and it is not generally so good a test as that of the vibrating vocal chords. These latter, namely, produce sounds with which the patient is more familiar, even if not so intense or high sounding as those of the above-named instrument. The perceptive or auditory region of the brain, when taking cognizance of sound under difficulties of both middle ear and nervous transmission, cannot always differentiate between sounds transmitted by means of the normal mechanism, though badly, and those transmitted through other media. When in doubt, the patient usually fancies they are "felt." Hearing in some very deaf persons, though extremely defective in quality, seems to take place through the tissues of the head without the aid of the transmitting mechanism of the middle ear. Thus, it was found in a case of almost total deafness from chronic middle ear inflammation, examined by Dr. C. H. Burnett and the writer, that loud voice heard at a few inches from the ear was equally distinguishable when both meatus were completely closed by the fingers, the words being spoken at the back of the patient's head.

So far as the treatment is concerned, in cases of extreme deafness as a result of chronic inflammation, differentiation is not important, whilst in slight cases diagnosis is less difficult.

Prognosis. The prognosis of chronic inflammation of the middle ear depends upon the age, general health, and existing degree of defectiveness in the organ. This latter cannot always be determined by the appearance of the drum-head, since, in many cases where fixation is irremediable by ordinary treatment, but little change in the

appearance of the transmitting mechanism is found. Where great fixation on the one hand, or extensive loss of tension of the transmitting mechanism on the other hand exists, with extreme deafness, but little improvement may be expected from other than surgical interference.

In by far the greater number of cases, however, the progress of the inflammation may be more or less controlled, provided the patient submits to proper hygienic regulations; indeed, in progressive sclerosis this is a *sine qua non*.

Treatment. For no other ailment is relief so confidently sought in vain as chronic catarrhal inflammation of the middle ear; and in no other is there greater reluctance to accept the prognosis, so often made by the candid consultant, in respect to the irremediable nature of sclerotic transformation of the mucous membrane, which has for its chief symptoms deafness, autophonia, and noises in the head.

In a very large proportion of these cases, our treatment must be directed rather to prophylaxis than cure, and, unfortunately, many persons, whilst greatly concerned about the ills they have, are unwilling to take measures to prevent those of the future. The very first step, however, should be to remove or diminish exciting causes to as great an extent as possible, bearing in mind that certain predisposing influences, such as heredity and constitutional taint, are more or less beyond control, and that, at best, our efforts may arrest the progress of the trouble only.

Remembering the progress the disease has already made, and taking into account likewise the results of previous purulent processes in the middle ear, if any, the surgeon may avoid the opprobrium of attempting to cure by treatment a case that can be alleviated only. The mistake is often made by resorting to measures strictly local, or, at furthest, of including the throat.

In laying out a plan of treatment, we shall find in a very considerable number of the more important cases, where there are distressing symptoms of autophonia, noises in the ear, and deafness to greater or less extent, that the consideration of mental disturbance is of the utmost importance. Thus, depression from worry or overwork or undue excitement should be eliminated, if possible, from the causative influences. Methods of diverting the patient's mind need not be gone into here; the success attending the medical adviser in any particular case depends on his own resources in this direction.

The condition of the mouth should not be overlooked, as it often is, when the naso-pharynx is examined. Carious teeth, which have been stopped where the pulp has been removed or is irreparably dis-

eased, may be the source of much danger; this is especially liable to be the case in run-down subjects, and, in considering the advisability of retaining such teeth in the mouth for the purpose of masticating, the disadvantages in nearly all cases outweigh any possible benefit. The reader will find, however, the importance of decayed teeth, etc., as factors in the production of aural diseases fully discussed in Chapter VII.

The sympathetic relations of dental irritation with acute processes in the ear have already been alluded to; their continuance, even when imperceptible to the patient, may keep up aural irritation until trophic changes manifest themselves in that organ. The writer, perhaps, has dwelt here and elsewhere upon this subject with seeming prolixity, but its importance from his point of view can scarcely be overestimated, and the success in treatment that has often followed the removal of such sources of irritation has been too manifest to him to admit of any doubt as to its necessity.

The naso-pharynx should come under treatment along with the ear in all cases, for one cannot be successfully treated without the other; moreover, in a certain sense, the affections of these regions are to some extent retro-active in their sympathetic relationship to each other, since we must regard the area of expanded mucous membrane at either extremity of the Eustachian tube as separate organs in name as well as in special nerve distribution.

During the acute exacerbations which temporarily increase deafness, and thus bring the patient to our notice, treatment should be the same, tentatively at least, as for an otitis media acuta.

Of the more remote regions likely to affect the patient, as the stomach, uterus, etc., nothing need be said here further than that they should not be overlooked where the case is under consideration, whether in council with the family medical attendant or otherwise.

Having suggested what the general course should be, there is but little remaining to be said about treatment. Inflation of the ear by means of Politzer's valuable method may be of service in some cases for loosening up slight fixation of the mechanism and, perhaps, also in hastening the reabsorption of undue accumulation of serum or mucus. It should not be resorted to with such frequency as to endanger tension of the mechanism, an accident that might occur where the Eustachian tube was widely expanded.

The hygienic management of chronic catarrhal inflammation of the middle ear, though mentioned last, is first in importance; it should embrace attention to both the individual and his surrounding, namely, to the quality and quantity of food taken, bathing, clothing, and

exercise, and to the ventilation and heating of habitations, etc., as well as to the vicissitudes of climate. All of these matters have been more or less touched on elsewhere.

In regard to surgical measures in cases of chronic catarrhal otitis media, the reader may consult Chapter XVII.

OTITIS MEDIA SYPHILITICA.

Subjects of secondary syphilis are liable to invasions of a specific nature affecting the mucous tract of the middle-ear, and arising for the most part concurrently with hyperæmia or subacute (catarrhal) inflammation of the organ.

Both ears are usually affected simultaneously, though not always in the same degree. Among none of the cases coming under the author's observation has either ear altogether escaped.

Objective Symptoms. The visible anatomical appearances of the ear are not particularly characteristic, and are by no means commensurate with the gravity of the trouble. The inner end of the external auditory canal is often somewhat hyperæmic; the epidermis of this region, and of the drum-head, may exfoliate, the membrane having a thickened, opaque, and lustreless appearance. Sometimes where the Eustachian tubes are closed, in consequence of inflammation at either their pharyngeal or tympanic orifices, the drum-head will be retracted, and consequently more hyperæmic than otherwise. Usually the tympanum contains no fluid, as the writer has found by performing paracentesis.

Subjective Symptoms and Course. The invasion is characteristic, being usually *sudden* and the *deafness absolute.*

In one case, the invasion was so rapid that, although hearing was good in one ear at night on going to bed, when the patient awoke the following morning it was entirely gone. The other ear had two years previously become deaf with even greater suddenness. The patient experienced a detonation, which he compared to a pistol shot, and vertigo and vomiting immediately preceding both attacks.

Pain is seldom experienced, though in some instances otalgia, due to reflected irritation, as from defective teeth, occurs. The autophonia and noises in the ear are very often almost unbearable. The following case presents some of the characteristic symptoms of the disease:

Patient, a male, 31 years of age, with the history of constitutional syphilis, contracted some six months before. Fifty days before being seen by the author, he had suddenly become very deaf, and at the

same time was much afflicted with frontal headache and vertigo. No deafness had been noticed previous to this attack. Both ears seemed to be similarly affected as regards the deafness.

Patient has pains in back of head, extending to neck and ears. There is decided naso-pharyngeal catarrh. Many of his teeth are carious. The general condition of the patient was fair, however, under the circumstances. The inner ends or extremities of both meatus are hyperæmic. The drum-heads are not thickened in appearance, but have a humid aspect. Extending to the dermoid layer of both membranes from the meatus, is the same moderately hyperæmic condition characterizing the latter. The hyperæmia is more marked about the short processes, and it extends down along the malleus handles. The membranes were furthermore retracted, especially the right one. Much tinnitus aurium existed. Patient cannot understand anything, even when shouted. Intensely loud tones of high or low pitch are heard, and best heard when in a noise. He can hear his own voice, and can sing in tune. Tissue-conduction exists for the tuning-fork when placed on the skull.

Under a treatment of iodide of potassium, together with inunctions of mercurial ointment, followed later by the mixed treatment internally, the hearing improved so much that loud voices could be heard and understood in the right ear at a distance of six feet or more.

Out of 118 cases of syphilis affecting the ear, seen by the writer, 86 cases occurred in connection with otitis media (catarrhalis) chronica, and 9 cases in acute non-suppurative inflammation of the middle ear.

The accompanying vertigo and noises in the ear would seem to be due to pressure upon the fenestra ovalis or rotunda from the drum. To what extent the inner ear itself may be directly affected in these cases cannot be discussed in this connection. The writer surmises, however, that nervous irritation, transmitted from the middle ear, may account for some of the phenomena, without supposing that inflammation of the auditory nerve exists.

Pathology. It may be surmised that, in the more severe cases, granuloma, or circumscribed, round-cell infiltration takes place within the tympanum; that the invasion is rapid, and that the conductive apparatus is thus prevented from performing its movements, owing to the particular manner of fixation that occurs. A more or less rapid deposition of lymph probably takes place in all of these cases, causing almost instantaneous or greatly increased deafness from fixation of the ossicles.

Diagnosis. In the more pronounced cases this is not difficult, though sometimes syphilitic infection is denied, in which event confirmatory evidence may be found on making a physical examination of the patient. From his own experience, the writer believes that specific

invasions of the ear milder than those described above frequently occur, since we have hitherto only had attention directed to cases where deafness has been total, or almost so.

Prognosis. In the more grave cases, very little improvement usually occurs from treatment; but when seen early, the less severe cases are more or less remediable. In all cases where syphilis complicates middle ear inflammation, the prognosis may be said to be, in consequence, less favorable.

Treatment. No local treatment is indicated beyond the moderate inflation of the drums by Politzer's method. Constitutional measures should embrace remedies known to be of service in secondary syphilis, viz., mercury, and iodide of potassium. The biniodide in small doses of $\frac{1}{60}$ of a grain, has been found beneficial, given four times a day. The writer does not believe that the excessively large doses of iodide of potassium sometimes given are always judicious; from three to five grains of the iodide, given in connection with $\frac{1}{30}$ of a grain, or even less, of the bichloride of mercury, has been attended with satisfactory results in his experience. It must not be forgotten that the patient, in these cases, is suffering from inflammation of the middle ear, modified by the syphilitic dyscrasia, nor that it is also important to attend to any existing oral or naso-pharyngeal irritation that may be present.

CHAPTER XIII.

OTITIS MEDIA SUPPURATIVA.

Acuta; Chronica.

OTITIS MEDIA SUPPURATIVA ACUTA.

This form of inflammation of the middle ear is one affecting the mucous and submucous lining of this region and which is attended by the formation of pus. It is ushered in similarly to acute non-suppurative inflammation of this region, and may prove to be of as brief duration as that process. Thus, in the beginning, especially where the atrium is alone or chiefly affected, the trouble is often never brought to the otologist's attention; indeed, unless there is much pain or pronounced deafness, is not always always considered important enough to consult the family physician concerning it. This affection may, furthermore resemble the acute otitis media, inasmuch as it frequently comes and goes, again and again, as the causative influences appear and disappear, before it is thought to be serious enough to require medical aid. It is, in fact, too often regarded as an "earache only," which should be left to nature to get well! Suppurative inflammation, however, in many instances commences in a severe form, involving the mucous and periosteal layer; and it is by no means always limited to that portion of the organ most easily seen, namely the membrana vibrans, and the atrium of the tympanum, which lies immediately beyond the former, but the attic of the tympanum, the antrum, mastoid, and neighboring cellules will often also be found affected. Inflammation of the periosteum, so often present, constitutes the chief feature of interest in these cases, since it underlies the entire mucous tract of the ear and, extending outwardly, envelopes the external auditory canal and peri-auricular surface of the temporal bone. The periosteum, when inflamed, may deprive a large area of osseous tissue of its source of nutrition, and the importance of the case, therefore, bears a direct relation to the gravity of the invasion and the patient's power of resistance.

Etiology. In considering the etiology of the purulent form of acute inflammation of the middle ear, it should be kept in mind that the initial pathological phenomena are similar to or identical with those of the acute non-suppurative affection already noticed. It is of frequent occurrence in the first weeks of infancy. Thus among 628 cases of acute purulent inflammation of which records were made by the author, were twenty-eight under one year of age, as follows :

Age.	Males.	Females.	Total.
Six weeks	..	3	3
Nine weeks	1	..	1
Ten weeks	..	1	1
Two months	2	3	5
Three months	2	..	2
Four months	2	..	2
Five months	1	1	2
Seven months	2	1	3
Eight months	1	..	1
Nine months	1	1	2
Ten months	2	1	3
Eleven months	2	1	3
Total	16	12	28

In a large proportion of children under ten years of age a general inflammatory condition of the upper air-tract is especially notable. The disease is sometimes accompanied by gastric disturbance, rhinitis, earache and fever showing a tendency to periodicity. Such a condition in young children, who are unable to describe their symptoms intelligently, is frequently termed "malarious," the advent of an aural discharge first disclosing the nature of the affection.

Table showing age and sex in 628 *cases of acute purulent otitis media.*

Age.	Males.	Females.	Total.
Under 1 year of age, as given above	16	12	28
Between 1 and 2 years	6	13	19
Between 2 and 3 years	11	13	24
Between 3 and 4 years	10	8	18
Between 4 and 5 years	8	13	21
Between 5 and 10 years	21	29	50
Between 10 and 20 years	78	26	104
Between 20 and 30 years	117	35	152
Between 30 and 40 years	67	32	99
Between 40 and 50 years	39	24	63
Between 50 and 60 years	23	9	32
Between 60 and 70 years	11	3	14
Between 70 and 80 years	2	1	3
Over 80 years	1	..	1
Total	410	218	628

Many of the *causative influences* giving rise to this trouble are, it will be seen, similar to those described in connection with acute non-purulent otitis media; prominent among these were syphilis, scarlatina and rubeola, maltreatment of various kinds and traumatism, exposure, and sea-bathing. The latter was among the most frequent of the active causative influences in the above recorded cases, since in nearly a sixth part of the total number of these patients the disease had been produced by sporting in the sea. Among predisposing causes and conditions present, irritation from dentition, diseased teeth, catarrhal states of the naso-pharynx, enlarged tonsils, etc., existed in at least half the number; conditions to be borne in mind in treatment.

Space will not permit a more detailed account of the causative influences in acute purulent inflammation of the middle ear; for further data the reader may consult the author's paper on "The Diagnosis and Treatment of Acute and Chronic Purulent Inflammation of the Middle Ear Tract and their Complications," read before the American Otological Society, July 20th, 1866,[1] in which will be found tabulated lists of active and predisposing causes, symptoms, etc.

Too much stress cannot be laid on the injurious effects in many instances produced by sea-bathing, Russian, Turkish and other baths, and to the entrance of fluids propelled along the Eustachian tube in sea-bathing or from the use of the nasal douche. It happens very often that the attic only is affected from these causes. This can readily be understood when it is kept in mind that the tympanic orifice of the Eustachian tube opens by a free sweep into the attic as well as into the atrium, and that fluids traversing the canal with considerable momentum would follow the upward sweep of the tympanic embrasure rather than gravitate downward. Moreover the presence of irritating fluids seems to be much better borne in the lower than in the upper part of the tympanum.

Objective Symptoms. It will generally be found on examining the ear at the beginning that the membrana flaccida is red, the vascular turgescence extending above on to the external auditory canal, and perhaps downward about the short process of the malleus. In favorable cases, a regressive stage may begin at this time, but frequently the inflammation extends from the attic along beneath the margo tympanicus of the auditory plate, and is attended with effusion of serum or blood; this raises up the membrana flaccida and the adjacent

[1] Transactions of the American Otological Society. Sixteenth Annual Meeting. Vol. 3, Part 5. 1886.

integument of the external auditory canal, which is quite loosely attached to the outer surface of the auditory plate. In some instances the bulging out of these parts is sufficient to form a sac, which entirely conceals the membrana tympani, or may even entirely fill the canal and present at the lumen as a purplish tumor. It would seem that, in some instances, rupture of blood-vessels belonging to the tympanic plexus takes place, giving rise to the sudden extravasation of a large amount of sanguineous fluid. The tumor thus formed does not always communicate with the attic at first, although later on it may do so.

The appearance of the drum-head to the inexperienced observer often gives but an inadequate idea of the gravity of the case, yet in the more severe cases some breaking down of the membrana vibrans occurs, more than one perforation frequently resulting.

Subjective Symptoms and Course. Infants, who are especially subject to reflex and vaso-motor ear disturbances during dentition, head catarrh, and gastric derangements, often give fewer pathognomonic indications than older persons. A discharge from the ear, even with peri-auricular swelling, may thus take place without any observable premonitory symptoms, and quite often spontaneous recovery follows so promptly that an incrustation of muco-pus in the concha of the affected ear, or a stain upon the linen, constitutes the only evidence of its occurrence.

Infants are, of course, unable to make known in an intelligible manner the distress experienced from deafness and autophonia, and the fretfulness consequent upon aural inflammation may be attributed to teething or other causes; it may often be inferred, however, that suffering from these phenomena or from pain is experienced when the child cries and puts the hand significantly up to the ear. The exhaustion resulting from worry and pain is sometimes very great, and may divert attention from the actual seat of disease to the brain itself, which, indeed, in these cases is only too liable to become affected by extension of the aural trouble. In older persons inflammation of the atrium of the tympanum is usually a much more painful affection, the subjective phenomena contributing to the distress, though the extent of these depends on the sensitiveness of the patient—very grave trouble not infrequently escaping detection, from absence of suffering. *Rupture of the membrana vibrans* as a result of disintegration, or the pressure of secretions, or from both causes combined, may take place in a few hours or after several days—pain becoming less or ceasing altogether. The subjective symptoms, how-

ever, do not always disappear with the subsidence of pain; they may even become more unendurable.

But inflammation in many instances does not go on to perforation of the drum-head, although suppuration may take place.

There is always some deafness and autophonia in purulent inflammation of the tympanum; when the attic alone is affected there is less than when the atrium is the principal seat of the trouble, since there is usually less interference with excursive movements of the membrana vibrans. Any inflammation of the drum, however, is liable to give rise to abnormal transmission of sound, which if heard loudly is yet wanting in distinctness. If great tension of the transmitting mechanism exists, low tones, as the rumbling of loaded trucks or horse cars, are heard as high ones, and sometimes give rise to painful sensations.

These phenomena pertain to derangements of the middle ear, and do not resemble disturbances of the physiological function of the auditory nerve. When the nerve is impaired by extension of inflammation to its terminal filaments from the middle ear, or by pachymeningitis, there is diminished perception of sound impressions, whilst disturbances (central) at its origin in lepto-meningitis, and perhaps in nervous exhaustion, give rise to dysacousma or cerebral hyperæsthesia (painful hearing) and vertiginous phenomena.

Pain in a large number of instances is generally distressing in the extreme. This, however, is by no means always a reliable symptom, since its manifestation depends on the physical susceptibility of the individual; the fortitude and apathy of both children and adults often being in this regard quite remarkable, and unless duly taken into account may lead us to underrate the gravity of the case. Sensitive and neuropathic persons, on the contrary, suffer greatly from comparatively slight causes. Intense pain may accompany either internal or external periosteal inflammation, and when these co-exist the suffering is no less than in pachymeningitis, from which differentiation is difficult, if not impossible.

Simple *Inflammation of the Atrium* may extend itself no further, but so soon as the attic takes on inflammation the process is nearly always propagated inwardly to the antrum and cellules, and to a greater or less extent outwardly along the canal, over the cortex of the mastoid and periauricular region generally. The symptoms are, of course, much more pronounced when both interior and exterior parts are affected at the same time, and the co-existence of periosteal inflammation of the mastoid cellules and cortex is almost certain to eventually cause caries of the bone. Inflammation is liable to extend

itself from the tympanum in this manner in nearly all cases, but the attendant symptoms and course of the disease depend greatly on the age and condition of the patient: in other words, its slight or severe phases are due to constitutional influences.

Inflammation of the Attic may develop consecutively to inflammation of the atrium, and, of course, both may be affected simultaneously. Inflammation of the attic, whether direct or by extension from the atrium, may, when the outlets therefrom remain free, pursue a favorable course without extending further; most frequently, however, the trouble extends not only outwardly, as already described, but owing to the swelling that takes place, the outlets into the Eustachian tube and atrium become obstructed, and pent-up secretions greatly aggravate the case. The mastoid antrum and cellules become involved, and pain is, for the most part, severe.

In inflammation of the atrium, as has been remarked, the drumhead, unless greatly thickened by former inflammatory processes, generally gives way to slight pressure, and relief is immediate and complete. When the attic is involved, however, the secretions are much more liable to be retained, and suffering may thus increase from hour to hour, and day to day, unless liberated by an operation.

Periostitis interna et externa. By this is to be understood an extension of the inflammation of the periosteum of the middle ear inwardly to the deeper parts of the middle ear tract, and outwardly to the walls of the external auditory canal, the mastoid cortex, and even to the entire circumauricular region. Sometimes the process extends mainly in one direction only; thus, when the antrum, mastoid, and adjacent cellules are affected, we have to deal with *periostitis interna;* when the walls of the external auditory canal and outer surface of the temporal bone are the seat of the trouble, it is described as *periostitis externa.*

The region affected in periostitis interna is a much more important one than that ordinarily invaded during the progress of periostitis externa. Thus the extensive mucous tract of the middle ear constitutes a large interosseous cavern, separated from the dura mater by a thin plate of bone only. Between the walls of this cavity and the brain, numerous nerves, blood-vessels, and lymphatics anastomose, by means of which the suppurative process may readily pass from one region to the other.

Periostitis externa may develop where the middle ear has not been seriously affected; the periosteal cortex may thus become intensely inflamed without implication of the mastoid cellules. Of this, however, more will be said later on.

Death occurs in infancy probably from suppurative phlebitis or pachymeningitis, consequent on inflammation of the ear, much oftener than is suspected, even when caries of the bone or pent up secretions could not be detected. The frequency of the presence of thickened dura mater over the tegmen on post mortem is notable, and, doubtless, many obscure cases of deaf-mutism owe their origin to unsuspected injury of the auditory nerve in this manner.

THE OCCURRENCE OF GRAVE CASES OF ACUTE PURULENT INFLAMMATION OF THE MIDDLE EAR.

The importance of certain grave cases of acute purulent inflammation of the middle ear is thought to be of sufficient interest to demand a separate consideration, as the deep tissues of the neck on the one hand, and the cranial cavity, through sympathy or extension via blood vessels or lymphatics, on the other hand, are more liable to be involved.

In acute inflammation of the attic, unless a regressive course is established, the secretions are liable to become imprisoned by closure of the outlets; this, together with the extension of periosteal inflammation outwardly along the roof of the adjacent canal, is attended by infiltration or suppuration; the membrana flaccida and adjacent integument become red and tumefied, and in the more severe cases their detachment from the tympanic ring and auditory plate takes place. The secretions now seek an outlet from the attic in this direction, distending the tumor more and more. There is not the tendency to rupture of the sac thus formed as when the lower portion of the drum-head is distended, since the former is not only much thicker, but being loosely attached permits secretions to easily burrow underneath. The liberated secretions now dissect their way out, first along the osseous walls of the canal and then along over the temporal bone in various directions, most frequently, however, posteriorly. In this manner the formation of what is known as a *Dissecting Tympano-Mastoid Abscess* takes place.

Sometimes along with the spreading periostitis externa, the subcutaneous connective tissue breaks down extensively, and an enormous periauricular abscess is formed, limited only by the temporal fascia; in other instances again the abscess is limited to the region of the membrana flaccida, or to the mastoid process. These dissecting abscesses, in the writer's own experience, occur most frequently in young children, as would be expected when the loose attachment of the drum-head to the auditory plate at this age is considered. In

such cases the canal and periauricular region sometimes swell up rapidly, and subside again as quickly, without abscess formation. In the adult where rhinitis sicca precedes the aural trouble, the mucous membrane of the middle ear tract takes on similar action, the retained secretions being extremely fetid. There is a tendency to chronicity in these cases, without much pain.

It is well to remember that in some cases of dissecting tympano-mastoid abscess the larger vessels of the mallear plexus, as it would seem, are ruptured, and a sanguineous cyst is formed by separation of the dermic layer from the drum-head and adjacent walls of the canal. These tumors vary in size from a small bleb to that of a sac entirely filling the external auditory canal and preventing any inspection of deeper parts.

Sometimes, after evacuation of the tumor, the integumentary walls of the canal collapse in consequence of their separation from the upper portion of the tympanic ring. In young children, owing to the greater flaccidity of the parts, detachment of the entire membranous wall from the tympanic ring may take place, as shown by the laxity of the canal and gurgling of secretions at its inner end on traction upon the auricle. In these cases there will usually be found caries of the tympanic walls and, in some instances, ulceration of the canal.

With periostitis externa, there is usually more or less asymmetrical prominence of the auricle on the affected side.

These dissecting tympano-mastoid abscesses usually, but not invariably, burrow along the superior-posterior wall of the external auditory canal; not unfrequently, however, they follow the superior-anterior wall. In the first named, purulent matter is generally found to finally make its appearance over the mastoid process; in the latter, above or in front of the auricle. Sometimes the entire peri-auricular region is involved, and in the more severe cases pus will burrow from the mastoid region posteriorly beneath the deep fascia of the neck as far as the median line of the occiput and even beyond, or downwards beneath the sterno-mastoid muscle and along the fascial layers underneath the trachea.

The pointing of a tympano-mastoid abscess may take place, furthermore, on the superior or posterior wall of the external auditory canal near the tympanum in some cases, even when at the same time bulging occurs at some point about the auricle.

Teat-like outlets, in many instances, sooner or later form in the drum-head, especially if the orifice be in the membrana flaccida. This process generally marks the beginning of a distinctly favorable change

in the course of the disease, and, in the more healthy subjects, recovery is from this time on usually rapid.

Discharge from the tympanum not infrequently finds an outlet at some point near the drum-head, where a dissecting abscess has opened on the posterior wall of the external auditory canal; the teat-like form of such openings is not so well marked as those just described. These sinuses are liable to be confounded with those which furnish an outlet from the mastoid cellules in this locality, but the latter are usually associated with fungosities and caries of the bone.

Secretions from the tympanum may later on, when suppuration has taken place in the mastoid, also escape by passing into the mastoid antrum, thence through the diseased cellular structure, and on out through a sinus in the cortex.

The unfavorable progress of these cases occurring in broken-down subjects is shown in the following:

A female, aged 30, came for the relief of acute purulent inflammation of the middle ear tract. There was nausea and vomiting; deep-seated pain in the mastoid, occiput, and vertex. She was a broken-down subject living under very bad hygienic conditions. Examination showed extensive detachment and bulging of the flaccid membrane and adjacent walls of the canal. The pent-up secretions caused great tension of the parts and gave rise to the symptoms mentioned. The purulent matter was liberated at the seat of bulging, securing ample drainage and relief; as the discharge lessened, a teat-like formation appeared, and recovery followed in two months.

Mrs. B. came to the infirmary suffering from the results of four miscarriages and the exsanguination from hemorrhage following a recent abortion. There was a dissecting tympano-mastoid abscess and difficult drainage, consecutive to acute purulent inflammation of the middle ear tract. Caries of the auditory plate and posterior wall of the external auditory canal, with protruding fungosities from a sinus in the latter existed. Notwithstanding repeated and free incisions into the sac, and removal of the presenting fungosities, recovery was much protracted.

Diagnosis. The management of a case of acute inflammation of the middle ear, especially in children, in order to arrive at a correct diagnosis and successfully treat the patient, will require both patience and skill. When a case of this kind is encountered, the suffering and nervousness of the child will generally interfere very much with the examination; and when the domestic establishment is anxious and worried from sympathy and vigilant nursing, their assistance is generally a hindrance rather than an aid. Under these circumstances, it will be often necessary to bring order out of chaos before attempting

to make an examination. A little firmness, however, and the service of a calm attendant, are usually sufficient to accomplish this, and tranquillize the patient. During the temporary lull which may confidently be expected, and while the patient is firmly held in the attendant's lap, the required examination can be made.

Whilst, as a rule, the diagnosis in adults is not difficult, in alarmed and struggling children it is not by any means an easy matter always; the canal may be naturally narrow, the swelling and secretions obscuring the parts. Co-existing exudative dermatitis of the inner end of the canal and the outer layer of the drum-head is liable to conceal the parts, and thus mislead the inexperienced observer. Underneath this exudation, the removal of which is painful and difficult, the dermic layer of the drum-head is seen to be dark red, and even purplish in color; later on, it becomes necrotic, and finally exfoliates. The whitish and somewhat inspissated exudative matter, which sometimes completely fills the inner end of the canal, has been taken for "diphtheria" of the ear by some authors.

The gravity of these cases is not always to be determined by the pain experienced or the appearance of the fundus; nor can a differential diagnosis be made in every case at first.

Pain is often not marked, even though the attic be involved and periostitis externa present; its existence or non-existence is, therefore, as has been before alluded to, often a question of temperament, and indicating rather the degree of tolerance of suffering than the extent of the disease.

The pent-up secretions in the attic usually, however, give rise to very great and persistent pain, and swelling and tenderness are experienced about the peri-auricular region.

A diagnosis regarding the seat of the disease is most important, since some cases are so simple that scarcely any other treatment is required than rest, cleanliness, and attention to hygienic measures; whilst, on the other hand, others are to be included among the more grave affections met with in practice, inasmuch as, if let alone, they may, by extension, involve deeper lying structures. The appearances of the drum-head afford a useful guide; where the atrium and membrana vibrans are the principal seat of inflammation, the latter is more or less red, and sometimes bulging. In severe cases, as already stated, there is often necrosis of the dermic layer, which then has a dead, ashy hue; sometimes this desquamates, leaving a purplish surface more or less rugous in look. But where the attic is also affected, or the disease is mostly confined to this region, the membrana vibrans may exhibit scarcely any of the above conditions. On careful exami-

nation of the parts, however, under good illumination, the membrana flaccida and adjacent walls of the canal will be found reddened, and the mallear plexus of blood-vessels more or less engorged.

When spontaneous perforation occurs later on in these cases of attic inflammation, the opening will be found, as a rule, in the membrana flaccida, having the appearance of a nipple, through which perhaps a small drop of pus may be observed to ooze. The nipple-like outlet from the attic through the membrana flaccida should not be mistaken for a polypoid growth, though a polypus may subsequently develop from the mucous membrane and present through this opening. The appearance of the drum-head is not always pathognomonic, even in the earlier stages of suppurative inflammation. Though it be found bulging, and its surface more or less red, we are not sure that reabsorption may not take place; and, on the contrary, what is seemingly a mild attack, without distention, may, in a few hours, manifest its nature by a copious discharge from the ear. Where the drum-head is thickened by previous inflammation, it does not yield so readily to pent-up secretions.

Pachymeningitis and cerebral abscess are often exceedingly difficult of diagnosis when occurring in connection with inflammation of the middle ear. Deep-seated, intense pain in the head, for a time continual and then, perhaps, intermittent for a day or more, and always increased on bending the head forward, may, in the absence of severe symptoms in the ear itself or about the mastoidea, be regarded as pathognomonic. Yet the fact remains that the pains of aural inflammation, if present, cannot always be differentiated from the above. Severe headache, vertigo, staggering, vaso-motor disturbances, as flushing, bilateral or unilateral sweating about the head, etc., are familiar symptoms in severe aural disease, even where a favorable result may be confidently expected. Prodromic symptoms by means of which the fatal termination of any particular case can be foretold are generally wanting. We are thus unable to distinguish the pain of meningeal irritation and neuralgic headache from the pains of periosteal inflammation of the ear.

A case, occurring in the writer's experience, of acute purulent inflammation of the middle ear tract, in a run-down female subject with marked neuropathic symptoms, occasioned apprehensions of the existence of pachymeningitis, and an eminent consultant was inclined to the opinion that the symptoms pointed to tubercular meningitis. Recovery, however, took place, and a review of the case seemed to justify the diagnosis of lepto-meningitis.

Usually when the more pronounced and recognizable symptoms of pachymeningitis and cerebral abscess manifest themselves, as convulsions, paralysis of some of the cranial nerves, coma or semi-coma, etc., the case has already passed beyond relief by surgical treatment directed to the ear.

Threatened brain trouble, so-called, is too uncertain a condition upon which to base a precautionary operation of opening up the cellules of the mastoid through its cortex, even were relief to be obtained by such means.

The aid of the ophthalmoscope has been invoked in determining the occurrence of optic neuritis or choked (congested) disk in connection with pachymeningitis due to ear disease, but this condition, when recognized, can, it would seem, but add another symptom to others, sufficiently convincing and already present.

The intermittent pains accompanying intermittent mastoid abscess are often severe enough to give rise to apprehensions, and are considered by some authorities as an indication for trephining the mastoid; in the writer's own experience, however, they have not been found significant of special danger.

It would seem that the pains attending a descending neuritis of the facial nerve in its passage through the mastoid might be misleading; the author has seen cases of this kind accompanying acute inflammation of the drum of the ear where the cellules of the mastoid were apparently not involved.

The appearance of the external auditory canal when the track of a tympano-mastoid abscess is manifested upon its posterior or superior wall by a bulging, purplish sac, may be mistaken for a polypoid growth, and when fungosities make their appearance after the sac ruptures or has been opened, the resemblance is, indeed, misleading. Fungosities, however, are seldom abundant unless the inner wall of the canal is carious, or where there is a sinus communicating with the mastoid cellules.

A dissecting abscess may reach the meatus externus, resembling the swelling caused by furuncular or diffuse inflammation, either of which may close the lumen.

Inflammation of the subcutaneous tissue or erysipelas sometimes extends into the external auditory canal from without, but does not usually give rise to periostitis externa; when occurring along with inflammation of the middle-ear tract a diagnosis is not so easily made.

The following case is instructive in connection with the question of diagnosis:

Acute Purulent Inflammation of the Tympanic Attic and Mastoid

Antrum caused by the use of the Nasal Douche for the Relief of Rhinitis Sicca. Pachymeningitis. Cerebral Congestion. Death.

The patient, 38 years of age, was employed as a railroad clerk. He was a strong-looking person who had led a rather exposed outdoor life.

For the relief of long-standing suppurative rhinitis he has occasionally employed the nasal douche, using a solution of salt in warm water. This practice has been followed a number of times by pain in both ears. Five weeks ago, after using the douche he immediately experienced pain in the right ear, which lasted all day, and a few mornings later he was awakened by its severity. From this time on the pains were severe, and in a few days a muco-sanguinolent discharge appeared, soon succeeded by a copious flow of muco-purulent matter. Although suffering greatly, for three weeks he kept on at his outdoor work, hoping that the ear would get well without treatment, but, the pain becoming unbearable, he finally consulted his family physician. He was advised to remain indoors, and given morphine freely, but the pains increased. The hypodermic use of morphine was now resorted to, and during the two weeks he remained under treatment at home the ear was constantly poulticed and syringed three or four times a day with carbolic solution, three drops of the acid to the ounce of water. The physician and his friends, being convinced that he was daily getting worse, decided to bring him to New York.

Examination at the New York Eye and Ear Infirmary, October 9th, 1882. The patient was evidently fatigued by the journey of 75 miles on the rails. He had the appearance of having suffered greatly; was anxious and depressed. Usually of a ruddy complexion, his face was now pale and the malar eminences flushed. The eyes were dull. The skin was humid, and he was closely wrapped in heavy clothing, though the day was not cold. He said he felt completely worn out from loss of sleep and the intense suffering he had experienced for five weeks. From being courageous he had become exceeding neuropathic and timid, and was specially nervous when his ear was examined. Laryngoscopic examination confirmed the existence of ozæna. The teeth and gums were healthy. The appearance of the left drum-head showed that chronic inflammation had long been present.

The right (affected) ear on examination showed the following: The external auditory canal was large; its inner end was red and considerably swollen; near the drum-head was a collection of dark greenish, thick pus.[1] The drum-head was red, the membrana flaccida fleshy looking and bulging. In front of the short process of the malleus is a mass of pouting granulation tissue, filling a perforation, in the centre of which is a small pulsating light reflex. The mastoid process is not red or swollen, nor tender to the touch. There is intense hemi-

[1] This dark-greenish purulent matter the author has found frequently in the subjects of ozæna—the suppurative action in the middle ear tract resembling that in the naso-pharynx.

crania on the affected side—localized points of tenderness over the temple and nape of neck. Hearing: ordinary voice in the right ear.

The attic membrane cleared up under treatment; the membrana vibrans, at no time after being seen much affected, was incised freely and the atrium was found almost normal—a little mucus only escaping. Valsalvan experiment showed that the passage from the throat to the drum was free throughout. The perforation in the membrana flaccida healed on cessation of the discharge, and the patient steadily improved, but up to the time of his departure for home the hemicrania continued off and on.

The subsequent history and report of post-mortem, obtained from his physician, was to the effect that, after his return home, on November 1st, the periodical attacks of frontal and vertex pain became more frequent and severe, without any discharge from the ear, and, coma supervening, the patient died on November 15th. Upon post-mortem examination the meninges and veins of cortex were found to be markedly congested. The temporal bone was not examined.

The examination of the case at the Infirmary left the impression that the severe remittent pains might be neuralgic, since they had continued so long with intervals of marked improvement. Were the pains those of pachymeningitis, however, this symptom indicated its presence from the outset, and, therefore, drainage having been good during the progress of the case, an operation on the ear would have been of no avail.

In contrast with the foregoing, is the progress of a case occurring in an athlete, a man of good constitution.

Patient contracted an acute inflammation of the tympanic attic, accompanied by intense pain, in consequence of taking a Russian bath. Excessive zeal in treatment had converted a simple case into a grave one before he came to the Infirmary, and when first examined it was found that a perforation in the drum-head which admitted drainage at the beginning, had closed up, and a dissecting tympano-mastoid abscess had developed. A bulging, fluctuating tumor presented on the posterior wall of the external auditory canal. A free incision was made into this, establishing free drainage. Soon afterwards, the perforation in the membrana flaccida reopening, the discharge began to escape readily through the tympanum. This opening now quickly assumed a nipple-like form as a markedly favorable change occurred; the sinus on the posterior wall of the canal closed, and an active regressive course was soon followed by complete cure.

The intense pain accompanying the periostitis externa in this case at the beginning, together with an interruption of drainage, afforded an indication laid down by some writers for trephining the mastoid process.

Prognosis. In cases of acute purulent inflammation of the middle

ear tract where a non-meddlesome plan of treatment has been adopted from the beginning the prognosis is favorable, both as regards life and preservation of hearing. In the many thousand cases of ear disease coming under the author's observation during a period of twenty years of special practice, of those seen at the beginning no fatal case has occurred; of the cases seen after severe symptoms had developed, fourteen cases have died—some of them so long after the aural trouble had abated that its influence as a factor could almost exclude them.

In very young children it seems probable that the acute purulent process is much more likely to set up meningitis than in older persons, and although statistics are wanting to establish the prognosis among this class, a grave or fatal issue is probably much more frequent than is suspected.

Treatment. In regard to the more simple cases of acute purulent inflammation, where the process does not extend beyond the atrium of the tympanum, but little need be said here, since in the greater number of these, as in otitis media acuta, the submucous structures are not seriously involved, and unless the patient's condition is unfavorable, or improper treatment has been the means of aggravating the case, their management presents no difficulties.

It is well, therefore, to prevent meddlesome interference and enjoin as complete rest as possible for the first few days. If there is free secretion of sero-sanguinolent or muco-purulent matter with obstruction of the Eustachian tube, the drum-head is usually ruptured spontaneously, but if found distended with advancing rather than receding inflammation, it is good practice to incise and give vent to secretions. This should be more promptly done if the drum-head be found thickened, either as a result of cicatricial transformation or recent engorgement and infiltration. Discharge having been established uninterruptedly, so far as otherwise healthy subjects are concerned, an expectant course, including attention to keeping the ear clean, is advisable. Cleansing the ear may be accomplished by gentle syringing, using as little water, well warmed, as possible, and drying out with the armed cotton-wool carrier. A weak solution of boric acid answers well, in some cases, for syringing. When catarrh of the entire upper air-tract coexists with the aural catarrh, minute doses of mercury have answered well in the author's hands; when "cricks" or "malaria" are present, small doses of quinine may be given, and if coated tongue with gastric disturbance exist, calx sulphurata is indicated and may take the place of mercury. The pain nearly always present in some degree may be allayed by mild nervines, as dilute tincture of pulsatilla, aconite, etc. Hot emollient solutions of boric

acid in cases where nasal catarrh is present may be employed by gargling or sniffing up the nose cautiously.

It does not seem good practice in the acute stage, or when healing of perforations is taking place, to forcibly distend the membranous portion of the drum by inflation.

Under the treatment outlined above, discharge gradually ceases in the majority of cases, but it may take place suddenly, in which event a cure must not be confounded with retention of discharge from an exacerbation due to exposure or other cause. Where pain is very severe, large doses of morphia should be tentatively given, with intermission of as great duration as possible, since consequent reaction leaves the patient much depressed.

The so-called dry treatment should not be commenced until discharge diminishes, and when perforations begin to close a tolerably firm incrustation of calendula and boracic acid powder, when it does not cause irritation, may be allowed to remain as a support to the drum-head. If the regressive course proves to be sluggish, the instillation of a few drops of calendula will hasten the healing process.

When the regressive course is established, outdoor life and attention to business may be resumed to a degree commensurate with the age and vigor of the patient. The writer has frequently seen cases where it was necessary to insist on the resumption of bodily activity. In broken-down subjects, supporting nutrition from the beginning is necessary.

The following cases are of interest, representing, as they do, a group of cases which respond readily to a very simple course of treatment, by which various instillations and vigorous syringing, so often injurious, are avoided, and shown to be quite unnecessary, a cure being brought about, and pain effectually relieved, by simple remedies internally administered.

Otitis media purulenta acuta. Marked constitutional disturbance, fever, and very severe pain. Patient discharged cured in one week.

Feb. 11th. Female, æt. 8 years, had pain in left ear, with discharge, two years ago. She attends a public school, where she is constantly exposed to cold draughts of air from the windows, which are opened to admit fresh air into the room when overheated by the steam radiator. Three days ago, after attending school, patient complained of pain, tinnitus, and deafness in her right ear, accompanied by marked constitutional disturbance, nausea, vomiting, and fever. Pain also in the left ear this morning. On examination, both drum-heads were found to be intensely and uniformly hyperæmic and bulging; no perforation, however, being visible. Patient could hear ordinary voice in both ears. She was restless and in much pain. Temperature 102.2°, pulse 130. The treatment consisted of the tincture of aconite and

extract of belladonna, given at frequent intervals, to control the pain; calx sulph. (gr. $\frac{1}{60}$) every two hours. It was hoped that the inflammation would take a regressive course, and paracentesis, therefore, was not performed.

12*th*. The right membrane has been ruptured, the pain has subsided, and there is a watery discharge. Aconite and belladonna discontinued.

14*th*. Patient has been resting well, and is free from pain. The discharge from right ear is more profuse, and of a purulent character. Canal syringed, and powdered boracic acid insufflated. The left canal is red and tender, the membrane fleshy and bulging slightly, but no perforation.

15*th*. Condition improved, and discharge diminished. Boracic acid insufflated. Left membrane less bulging, and injection subsiding. Calx sulph. (gr. $\frac{1}{60}$) every four hours.

18*th*. No discharge from right ear; canal filled with dry powder. The left membrane is clearing up. Calx sulph. discontinued.

Acute inflammation of attic and membrana flaccida. Severe pain, relieved in two days. Discharged, cured, in two weeks.

Male, æt. 8 years. No previous ear trouble. For past five weeks much pain, at times very severe, in right ear, with scanty discharge. Loss of sleep and appetite. On examination, free purulent discharge from right ear is found, and only the membrana flaccida of drum-head is seen, the same being fleshy in appearance and concealing the upper segment of the membrane. Hears ordinary voice with this ear. Left ear normal.

Aconite and belladonna were given to allay pain. Calx sulph., at first every two hours, afterward less frequently. Pain subsided in two days, and discharge ceased in eight. Fourteen days later the canal dry, and drum-head resuming rapidly its normal condition.

Acute inflammation of the middle ear. Autophonia. Pain relieved in three days.

Male, æt. 27 years, has long been subject to earaches. Head catarrh not marked. Whilst working is often obliged to stand knee-deep in water. For the past week pain and throbbing in left ear, accompanied by autophonous phenomena. Has used instillations of laudanum, but with no relief. The examination shows left canal filled with muco-purulent matter, the drum-head fleshy in appearance, with a small perforation in the posterior inferior segment. Hears ordinary voice with affected ear. Right ear normal.

Treatment as in previous cases. Pain and discharge had ceased by the third day. The dry powder in canal was left undisturbed for a time.

The gravity of complicated cases of acute purulent inflammation, where the entire middle-ear tract and exterior parts are generally more or less involved, is important enough to require separate and distinct consideration in regard to their treatment. They may be divided for this purpose into three groups: I. Those where drainage

from the antrum and attic is impeded; II. Those where a tympano-mastoid abscess has formed; III. Those where a mastoid abscess exists.

Attention to these cases will first be called, most likely, by the pain attendant on suppression of secretions. Whether this occurs in consequence of blocking up the outlets, by swollen mucous membrane, polypoid masses, sequestra or general periostitis, and inflammation of the subcutaneous connective tissue, no time should be lost in temporizing and ineffectual surgical procedures. In such cases it will rarely be found that the atrium of the tympanum alone is chiefly affected, since drainage from this region cannot so easily be arrested. It is the invasion of the tympanic attic and mastoid antrum and cellules and external periosteum that almost invariably gives rise to trouble of a severe character.

I. Where drainage from the attic and antrum through the tympanum is impeded: Directing attention in these cases first to the drum-head, we shall probably find that accumulations in the attic have finally bulged out the integument composing the membrana flaccida, increasing its dimensions at the expense of the superior wall of the external auditory canal above, and of the dermic layer of the membrana flaccida below. A free incision, carried well down through the distended tissues of the canal to the bone, and continued on along to the margin of the auditory plate and well into the membrana flaccida, should be made without delay. The author has found the knife shown in Fig. 43 well suited to this operation. Drainage is best secured when the incision is carried



FIG. 43.—Natural size.

freely into the attic where one or the other of the passages, situated on either side of the handle of the malleus, affords a natural outlet for secretions from the attic to the atrium. The timely interference by means of this operation may avert the more severe symptoms. Delay in these cases, where periosteal inflammation is extending itself outwardly from the tympanum, favors the development of dissecting tympano-mastoid abscess which may eventually involve the entire temporal region—limited only by the outlines of the temporal fascia.

II. *Where a tympano-mastoid abscess has formed:* Bulging of the tissues in these cases on the posterior wall of the external auditory canal should not be mistaken for an opening from the cellules of the mastoid; when it occurs in this situation, an incision should be made, even though an opening be required in some portion of the peri-auricular region—and when a counter-opening is thus made it is well to introduce some strands of catgut through from one to the other. Although in mild cases of periostitis externa, and inflammation of the subcutaneous connective tissue, reabsorption sometimes appears to take place, it is a safe rule to liberate purulent matter as soon as possible after its detection.

Nipple-like formations at the seat of perforations in the drum-head are liable to be mistaken for polypi, as been already remarked, and, indeed, redundant granulation tissue is sometimes present in the opening, but its removal is seldom advisable.

The following cases will serve to further illustrate the course and treatment of severe symptoms.

Acute Purulent Inflammation of the Atticus Tympanicus. Defective Drainage. Formation of a Dissecting Tympano Mastoid Abscess. Recovery.

Mrs. W., aged 38 years, came to the New York Eye and Ear Infirmary in April, 1886.

No history of previous aural disease. Six weeks ago the patient was taken with pain in the left ear, followed by a discharge. Three weeks ago the latter ceased; there was autophonia, and deafness, and headache became very severe. At the same time a painful swelling was noticed over the mastoid process. No vertigo or nausea. Upon examination, there is found asymmetrical prominence of the left auricle, and the whole post-aural region of that side is swollen, tense, and fluctuating in one spot. The posterior-superior wall of the external auditory canal is so much detached and bulging that a view of the deeper parts cannot be obtained. The meatus contains some inspissated matter. Patient hears ordinary voice in affected ear.

It was decided to effect drainage by an incision over the mastoid, and a large quantity of purulent matter was thus evacuated. As was suspected, a connection between the cavity of abscess and the atticus

tympanicus existed, being detected by careful exploration with the probe. Three days later the subjective symptoms had subsided, and the membrana flaccida and the membrana vibrans could now be seen. The perforation in the former had healed, and the latter was found to be unaffected. The hearing had improved to low voice. In five weeks the abscess had healed, and patient was discharged cured.

Acute Purulent Inflammation of the Tympanic Attic and Atrium. Dissecting Tympano-Mastoid Abscess. Caries of the Superior Wall of the External Auditory Canal. Recovery.

Albert J., aged 29 years, came to the New York Eye and Ear Infirmary in April, 1886. He indulges freely in the use of wine and beer; works in a damp, dark room, and is exposed to draughts of cold air while heated. Two months ago contracted a severe cold with pain in the left ear, accompanied by deafness and autophonia. Local applications of sweet oil, pieces of bacon, and the like were made, and he continued to attend to his work. Two weeks ago the whole temporal and mastoid regions became swollen and painful. He noticed no aural discharge.

On examination of the left ear, the superior-posterior wall of the external auditory canal was found so completely detached that a view of the deeper parts could not be obtained. There was some inspissated matter present, but no pus.

The left temporal and mastoid regions were uniformly swollen and tender, but no fluctuation could be obtained. Patient heard loud voice in affected ear. He had hypertrophic catarrh of the upper air tract, and carious teeth.

Pain was now increasing, and the patient complained of vertigo.

An incision was made through the membrana flaccida, and outwardly through the superior wall of the canal. This not proving sufficient to evacuate the purulent sac, more complete drainage was then secured by counter-openings made in the temporal and mastoid regions, and, subsequently, as the superior wall became more detached, its most dependent part was also opened. Strands of catgut were kept for a time in the sinus extending from the opening in front of the auricle to the one in the external auditory canal. On examination of the parts when thus opened up, the upper wall of the bony portion of the external auditory canal was found to be denuded and rough—the place being marked at the opening in the canal by a mass of granulation tissue. The operations were done under ether. The patient was advised to rest, and calx sulphurata was given. Pain was relieved by aconite. Improvement was rapid. The abscess healed up, suppurative action in the tympanum ceased, the openings cicatrized, and on the thirtieth day patient was discharged cured.

III. *Where a mastoid abscess exists:* From the foregoing it will be seen that the writer favors the practice of keeping open an outlet through the tympanum into the external auditory canal, for the purpose of draining the middle ear tract, rather than resorting to an

operation for the liberation of secretions through the intact cortex of the mastoid. Of course, where inflamed structures and the products of the inflammatory process give rise to accumulations in the mastoid and antrum, with great suffering from tension through inaccessible closure of the passage into the tympanum, an opening through the unaffected cortex of the mastoid or posterior wall of the external auditory canal would be indicated. The author has seldom encountered a case of this kind. Such cases must be rare, when the previous treatment has been proper.

When, however, we have to deal with urgent symptoms, it will usually be found that some local disturbance along the posterior wall of the external auditory canal or over the cortex of the mastoid process indicates an effort of nature to liberate pent-up secretions. Where the mastoid is swollen, and a regressive process does not look probable, no time must be lost in making an incision down to the bone, unless an abscess be sooner reached. This procedure is known as Wilde's incision.

The lower mastoid cellules, when the seat of purulent inflammation, discharge into the antrum when the passage is unobstructed, otherwise through the posterior wall of the external auditory canal or the cortex of the mastoid process. From his own observation, the writer believes that perforative caries takes place in the former quite as often as the latter situation. In external periostitis, the posterior wall of the canal is, perhaps, more frequently affected than the cortex of the mastoid process. Were there any indications to guide the surgeon in the detection of pent-up secretions in the cellules of the mastoid before a sinus had announced the fact, the author should not hesitate to perforate healthy tissues in order to relieve the patient; but he is aware of no such indications.

Where the inflammatory process, either an internal or external periostitis, or both, has caused the destruction of the cortex of the mastoid, the sinus should, of course, be kept open and enlarged by cutting or chiselling if necessary, remembering that the cranial fossa is only separated from the cellular structure by a more or less thin shell of bone. Special efforts need not always be made to maintain the opening after drainage through the natural channel has been established. Usually the cortical opening quickly closes spontaneously in a large number of cases so soon as drainage from the tympanum becomes efficient.

The urgency of the symptoms in certain cases, in view of a possible fatal result, has induced some authorities, however, to recommend

trephining the mastoid, and the following indications have been laid down for its performance by Schwartze:[1]

1. "In cases of *acute* inflammation of the mastoid process with retention of pus in its cells, when the œdematous swelling, pain, and fever do not subside after treatment with ice or Wilde's incision. In cases of secondary inflammation of the mastoid process, every cause for the retention of pus in the auditory canal and in the tympanum should be first removed. In this manner alone appearances of inflammation of the mastoid not seldom take on a regressive course, even where they are accompanied by quite threatening symptoms (high fever, continual pains in the head and neck, caput obstipum, and infiltration of deep-lying cervical tissues); but this improvement is, in most cases, only temporary, and in the course of weeks or months a change for the worse takes place, which finally renders the operation necessary."

2. "In cases of *chronic* inflammation with intermittent swelling of the mastoid, or where abscesses, resp. fistulous openings in the skin have already formed over the same, with abscesses in the lateral region of the neck, in the auditory canal or in the direction of the pharynx, *even if no immediate symptoms threatening life are present.*"

3. "In cases of *externally healthy mastoid*, where there is retention of pus or the formation of a cholesteatoma in the middle ear, and which may not be removed through the natural channels, *as soon as symptoms arise which render the appearance of a dangerous complication probable.*"

4. "In cases where the mastoid process (externally healthy and without retention of pus in the middle ear) is the seat and starting-point of continual and unendurable pain, for the relief of which all other means have failed. (Bone neuralgia)."

5. "As a prophylactic operation against lethal conditions consequent to incurable putrid discharge from the middle ear, where no appearances of inflammation in the mastoid and no other symptoms of the retention of pus in the middle ear (pain, fever) exist, other than the intense penetrating fœtor of the purulent discharge, in spite of the most careful cleansing and disinfection through the auditory canal and Eustachian tube."

Schwartze says, furthermore, that the chief sources of danger from the operation are profuse hemorrhage from the bone, exposure of the middle fossa of the skull or of the transverse sinus, and septic infection.

The same author states also that "aside from the contra-indications applicable to all larger operations (tuberculosis, when far progressed, diabetes, etc.), the operative opening of the mastoid has a special *contra-indication*, namely, where there are positive indications that meningitis or cerebral abscess already exist."

[1] Chirurgische Krankheiten des Ohres. Stuttgart, 1885, p. 334 et seq.

The "indications" thus laid down by Schwartze do not seem to the writer sufficient to warrant a frequent resort to the operation. To consider them somewhat in detail.

Of the first indication, it cannot be admitted that "œdematous swelling, pain, and fever" are pathognomonic of "acute inflammation of the mastoid process with retention of pus in its cells," nor should the author rely on an incision over the mastoid, or ice applications alone, to relieve inflammation of the cellules, even though the above symptoms were accepted as pathognomonic of this condition.

As regards the second indication, "intermittent swelling," it is of frequent occurrence in *acute* cases where drainage from the tympanum is interrupted by the closure of a sinus from the cellules of the mastoid, or by a clogging up of the tract of a dissecting tympano-mastoid process. It does not "threaten life."

The third and fourth indications may be taken as guarded opinions in respect to contingencies the importance of which are largely a matter of individual judgment.

In respect to the fifth indication of Schwartze, quoted above, one can but consider that an operation is recommended simply as a *dernier ressort*.

The views of Schwartze, as found in the literature of this country, can scarcely be said to fairly represent the opinions cited above; as thus taken from his recent writings there is little that cannot be heartily commended. It has seemed to the writer, however, that those who have been most prominent in professing to follow the practice of Schwartze in this country, if guided correctly by his early teachings, do not keep pace with the conclusions to be drawn from his later experience.

There can be no justification for the haste to trephine or chisel into healthy mastoid tissues, as lately evinced in this country. Thus advantage to the patient is said to result from carrying a canal from the mastoid cortex into sound bone, especially when the latter is hypertrophied from previous inflammation of the cellules. The writer is convinced that nothing is gained by such exploits, but that, on the contrary, they are to be deprecated. One of the cases, briefly described on a previous page, presented almost, if indeed not all, of the symptoms laid down by some writers for opening the mastoid; for, in addition to other symptoms mentioned in the report, there was intermittent swelling over the mastoid, intense vertigo, nausea, and vomiting, with elevation of temperature. All of these symptoms, however, disappeared on the establishment of drainage by a free opening

into the posterior wall of the external auditory canal, where the pointing was prominent.

Where periostitis interna is suspected of having reached the cellules, it has been the author's own experience that drainage for the entire middle ear tract can best be maintained through the natural channel of the tympanum, and following out this course in practice has never been to his knowledge attended with fatal results. But should the difficulties attending this operation be urged against its adoption, it may be said in reply that no safe guide indicating the employment of the trephine, either for the prevention or for the relief of pachymeningitis, is known. Trephining into the mastoid for threatened pachymeningitis in this manner could only be regarded as a warrantable surgical procedure at an early stage when, unfortunately, no sure pathognomonic symptoms are recognizable.

One cannot but regard the expressions "threaten life," "brain symptoms," "symptoms of cerebral irritation," and the like, too frequently used in this connection, as untenable assumptions, and misleading, and which, when accepted too confidently, tend to increase the importance of misconceived indications rather than the establishment of sound surgical principles.

It seems by no means improbable that the course of many cases of purulent inflammation, with symptoms that "threaten life," alleged to have been cured by the intervention of an operation of trephining, would have been equally and very probably much more satisfactory without this procedure. The patient's testimony as to relief in these cases must, as often happens after seemingly important procedures, frequently be taken with some allowance; it is often of no value whatever; and, moreover, the advantages of the preliminary incision through the integument, where indicated, should be considered.

The results of this operation (trephining) are sometimes by no means as harmless as its easy performance would indicate, for fatal results are not at all uncommon, and we may in any case convert a simple catarrhal inflammation of the pneumatic cells into a most troublesome ostitis. Inasmuch as the danger of cerebral complications does not necessarily arise from the pressure of pent-up secretions, but rather from transmission by contiguity, anastomosis of vessels, etc., trephining cannot always, even when pus is liberated, be relied on to prevent their occurrence, however early it may be performed. In acute otitis media the mastoid region may be greatly swollen externally; there may be much pain, and yet an extension of the middle ear inflammation to the dura mater may take place, while the mastoid cells remain comparatively free of any complication;

under such circumstances, if pain and swelling of the peri-mastoid tissues were to be taken as indicating the necessity for trephining the mastoid, we should then have, were the operation performed, a serious wound of this bone added to the other grave conditions that attend inflammation of the meninges of the brain. The author cannot but believe, viewing the matter in this light, that the operation has been needlessly performed in a great many instances. It is stated by most authorities that this operation is usually followed by the relief of the urgent and threatening symptoms, together with the pain. It is difficult to understand how this can be, especially in cases where cerebral disease arises from direct transmission from the middle ear and the communicating mastoid antrum, or from previous absorption from the mastoid itself; and when neuralgic pains have their origin in other parts, relief from this operation is likewise improbable.

Intense inflammation of the tissues over the mastoid process, with redness and swelling, in the course of acute inflammation of the mucous tract of the ear, does not, however great the accompanying pain, always require active interference ; the symptoms very often disappear spontaneously—especially in young children they frequently disappear as quickly as they come. But where such symptoms persist, a free incision carried down to the bone will often be advisable even before fluctuation is detected.

Meningitis may suddenly develop in cases where the aural symptoms have not been severe or alarming; on the other hand, the most urgent muco-periosteal inflammation of the middle ear tract may exist, with so-called brain symptoms, without brain lesion.

The success so far attained in affording drainage through the tympanum in purulent inflammation of the middle ear tract, and the doubtful benefit to be derived from an exploration into osseous tissues of the mastoid process, when possibly healthy, have deterred the writer as yet from the latter procedure.

It should not be forgotten, in observing the progress of caries of the temporal bone, that it differs from that of any other bone, since it has a large mucus-lined cavity, the secretion from which very much increases the difficulty of treatment. It has the advantage, however, over other bones during inflammation, of possessing a nutrient periosteal membrane, lining it within, whilst covered by the periosteum without, thus insuring rapid restoration under favoring conditions.

OTITIS MEDIA SUPPURATIVA CHRONICA.

The form of disease to be described under this name is a sequence of unchecked or badly managed acute inflammation of the middle ear, especially in those persons whose habits or general condition tend to favor chronicity. This result, indeed, is not an unusual occurrence in spite of the best possible treatment.

Etiology. In a large number of patients seen, the disease has existed for many years, having begun in infancy.

The following table exhibits the ages and sex of over twelve hundred of the author's cases:

AGE.	MALES.	FEMALES.	TOTAL.
Under 1 year of age	8	7	15
Between 1 and 2 years	18	7	25
Between 2 and 3 years	16	22	38
Between 3 and 4 years	16	26	42
Between 4 and 5 years	8	29	37
Between 5 and 10 years	83	119	202
Between 10 and 20 years	211	165	376
Between 20 and 30 years	155	82	237
Between 30 and 40 years	80	46	126
Between 40 and 50 years	40	33	73
Between 50 and 60 years	32	14	46
Between 60 and 70 years	10	1	11
Between 70 and 80 years	2	..	2
Total	679	551	1,230

Of the patients under one year of age the youngest was two months, the eldest eleven months.

Among children the unfavorable influence of a depraved constitution, favoring the continuance of hypertrophic rhinitis, enlarged tonsils, and disturbances of dentition, was shown in the nature of the aural trouble. With profuse secretion of muco-purulent matter in the ear, discharge from the nose and eyes, and in numerous instances, eczema of the face and head frequently occurred. Examination of the fundus of the ear showed more or less destruction of the drum-head, whilst the tympanum in the more active cases was usually found filled with exuberant granulation tissue and sero-sanguinolent or muco-purulent matter in varying relations. The discharges were very often offensive smelling, and gave rise to an ulcerated condition of the external auditory canal over which they flowed. The course of the diseaes in these broken-down subjects generally manifested but little tendency towards spontaneous improvement until treatment had

brought about a favorable change in the general condition, especially of the naso-pharynx.

In but few cases of protracted otorrhœa will it be found that either consumption, syphilis, scrofula, or some dyscrasia has not its influence, or that reflex irritation or vaso-motor influences have failed to prolong the trouble.

The alleged origin of a large number of instances of otitis media purulenta chronica in scarlet-fever or measles is rather misleading, though we cannot always verify our suspicions in this regard. It seems to the writer, however, that many of the cases alleged to be the sequelæ of the diseases mentioned are due to other causation, the chronicity depending not so much on any special influence imparted by the exanthemata as on the unfavorable condition of the patients themselves. There can be no doubt of the fact, nevertheless, that many of the most destructive aural inflammations arise during the course of the exanthemata (Chapter V.).

Objective Symptoms. Since purulency has usually been of long standing before we are called upon for aid, the ear drum will be found to have undergone greater or lesser changes in most cases.

The results of destructive inflammation of the drum embrace loss of substance of the drum-head on the one hand and cicatricial reproduction on the other; displacement and caries of the ossicles, and an almost endless variety of deformities of the transmitting mechanism, in consequence of the pathological changes due to destructive inflammation. As a result of suppurative inflammation of the atrium, one or more (usually one only) perforations may be observed of greater or less size; whilst more or less granulation tissue will be found on its walls. Sometimes polypoid growths are also present. The more important cases, however, are those in which the attic has been involved, with one or more sinuses leading through the membrana flaccida into this cavity; one only as a rule, but sometimes one in front and one behind the hammer, a posterior opening being most frequent. Very often cases are encountered where the membrana vibrans is absent, a fringe-like border above being left, comprising the membrana flaccida; in such cases the ossicles may remain in situ though usually more or less diseased. Sometimes the malleus, or its handle, or the incus is absent, and frequently both of these ossicles are missing. The incudo-stapedial articulation may or may not be found remaining even where all three of the ossicles are present.

The malleus and incus are often adherent to each other in varying degrees of attachment; and the head of the malleus becomes frequently attached to the tegmen tympani.

In a large number of cases, however, the inflammatory process will be found to have extended backwards along the petro-mastoid canal into the mastoid antrum and cellules (see Fig. 45), and even to those cells lying in the tegmen or above the external auditory canal. In many instances where the drum-head has been destroyed, to a greater or less extent, and the ossicles are missing, on looking into the ear, a large cavern, embracing the tympanum, mastoid antrum, and some of the cellules is seen and which remains during life. This pathological cavity in certain cases opens outwardly by a larger or smaller canal through the mastoid cortex behind the auricle; the cavity is usually lined, when a cure has taken place, by a white, polished surface of uncovered bone or cicatricial tissue. In some cases, however, we shall find the mucous membrane, especially of the antrum, infiltrated and filling these cavities, assuming a gelatinous character. Where the mastoid cellules have been destroyed by inflammation, especially in youth, it is not uncommon to afterwards find a cicatrix behind the auricle in place of the open sinus just mentioned. When the inner tympanic wall also gives way to caries and necrosis, the labyrinth is included in these caverns, which usually contain more or less desquamative material, cerumen, and other débris. Occasionally the margin of the auditory plate, forming the upper portion of the tympanic ring, is also missing, and more rarely, in children, the entire auditory plate is detached. When to this is added the destruction of a portion of the tympanic process, the deformity is, of course, much increased. The thickened remnants of the drum-head are often found retracted and adherent to the inner wall of the tympanum, thereby partially occluding the outlets from the attic and antrum. In these cases polypoid masses are frequently met with, sprouting from the antrum or attic, and protruding through the perforation in the membrana flaccida, or dipping down behind the membrana tympani into the atrium. A deep sinus is present in some cases of chronic inflammation of the middle ear, containing often either pultaceous matter or inspissated pus, sometimes polypoid tissue or epithelial crusts, and leading through the membrana flaccida or inner extremity of the external auditory canal up into the attic, and in some cases from thence into the antrum.

Von Troeltsch, who observed these sinuses twenty-five years ago, believed that they were due to perforation of the roof of the external auditory canal in cases where the cellules, sometimes extending over this region, were the seat of disease. That their origin may be thus explained in some cases the writer has no doubt, but more frequently they depend on perforation of the membrana flaccida. Subsequently

to Von Troeltsch's observations this condition of things attracted the attention of others; several cases came under the observation of Dr. J. O. Green,[1] who regarded the trouble as beginning with a catarrhal inflammation, which afterwards became purulent, involving to a greater or less extent the entire tympanum, "but," he says, "the mucus secreted among the ligaments and other structures in the upper part of the tympanum is unable to gravitate to the floor of the cavity on account of its confined position."

Both Drs. C. H. Burnett and C. J. Blake reported cases also.[2] Subsequently the latter writer drew attention to acute invasions of the upper part of the tympanum,[3] observing that the tympanum becomes inflamed during the first few hours, at the furthest in twenty-four hours, and, that when the membrana tympani was opened, it gave vent to a copious serous discharge. He seems scarcely to have considered the affection as rising altogether independently of the atrium of the tympanum, a view also apparently accepted by other writers.

Discharge. This is more or less profuse according to the extent of destructive inflammation; exposure of bone, caries of the drum generally, favors the development of granulation tissue, and upon this and the action of the mucous surface depends largely the quality and character of the secretions composing the otorrhœa. With a free and bad smelling discharge, especially in young patients, we often find the canal ulcerated, swollen, and very tender, as in acute purulent inflammation of the middle ear. The itching consequent on this condition sometimes induces scratching and picking of the parts by the patient, which, of course, goes to increase and exaggerate the irritation.

In some cases of protracted inflammation, the secretion is almost exclusively purulent, and becomes inspissated, sometimes tough and pultaceous; of such material are cholesteatomatous masses in part composed.

Secretions are sometimes exceedingly offensive; this is due, in a great measure, to neglect of cleanliness, especially in hot weather, and in children over-proliferation is most common and marked. The offensiveness of the discharge is often increased from its being pent up in the tympanum, owing to the presence of polypi. For a description of aural polypi the reader may consult Chapter XIV.

[1] An unusual variety of purulent inflammation of the tympanum. Boston Medical and Surgical Journal, March 6th, 1874.

[2] Meeting of the American Otological Society, 1874.

[3] American Journal of Otology, April, 1882.

Subjective Symptoms and Course. Pain is an occasional symptom often due to reflected irritation and manifesting itself as neuralgia about the ear and temporal region, sometimes with more or less headache or hemicrania.

Autophonia is experienced in some cases, especially where a considerable portion of the drum-head remains.

Noises in the ear are nearly always present, but they are not so common as in acute processes. Usually it is only where an acute exacerbation sets in, as an accompaniment to head colds, that pain and tinnitus are of a nature to cause any apprehension or trouble to the patient (see Chapter XVI.).

Deafness is, however, the most unvarying and pronounced feature of the trouble, varying according to the defectiveness of the transmitting mechanism or injury of the deeper lying structures in which the auditory nerve is distributed.

Vertiginous phenomena are frequent, especially in the run-down class of cases, in whom purulency is so often found to exist. This feature is particularly manifest in operative procedures, or in probing or syringing the ear.

Reflex phenomena. The aural reflex is most significant, and was observed by the very earliest writers on the ear. It will be found to exist in some degree in nearly every case of aural disease, but more especially in the class under consideration here, its most frequent symptom being what is usually called "ear cough." The latter phenomenon occurs in numerous cases on the introduction of a speculum or the manipulations to which the ear is more or less subjected during treatment. Other reflex phenomena arising from the same causes often manifest themselves in almost every region of the mucous lining of the upper air-tract. As examples of such may be mentioned the sensation of tickling in the throat, an irresistible desire to swallow, tingling in the tongue, sneezing, and often vomiting, experienced by different individuals during the progress of aural examinations and manipulations.

A chronic purulent process often exists from infancy to old age without receiving any attention or in any way alarming the patient. The tolerance of a "running ear" with its attendant symptoms is largely a social question unless, indeed, pain is severe. This may be plainly seen in contrasting private practice with hospital experience; in the latter, cases are constantly met with that have existed a long time without treatment. Where purulent secretion is slight, it often dries up in the drum or canal as rapidly as formed; when masses of inspissated matter thus collect, they are picked out by the patient or

escape of themselves, and are almost indistinguishable from hardened wax.

In certain instances, however, where, as mentioned before, a greater or less area of mucous membrane remains in a pathological condition, the secretion of muco-purulent matter from this surface continues, and is sometimes so abundant that tissues which have already undergone cicatricial transformation again become unhealthy.

Sometimes this swollen state of the mucous membrane of the deeper portions of the middle ear tract remains for years without causing any symptoms; but should caries of the bone occur, urgent symptoms may arise from impeded drainage.

THE OCCURRENCE OF SEVERE OR GRAVE SYMPTOMS IN THE COURSE OF CHRONIC PURULENT OTITIS MEDIA.

The writer has above alluded to the fact that, under certain pathological conditions, drainage of secretions from the attic may be much interfered with, and, in the event of an acute exacerbation of the chronic purulent process, inflammation of this cavity may become a



FIG. 44.—SINUSES LEADING THROUGH MASTOID CORTEX FROM ANTRUM AND TYMPANUM, IN A CHILD. FROM A PHOTOGRAPH.

very serious affair. Thus with an *acute exacerbation* of the disease, the escape of purulent matter into the atrium, auditory canal, or Eustachian tube may be effectually prevented, just as we find in acute processes, and extension of the inflammation to the cranial cavity is likely to occur.

When the proportionately large area of the middle ear tract in children is considered, one need not experience any surprise at the frequency of its serious invasion by disease. The tympanum, antrum, and Eustachian tube thus comprise a very much exposed region occupying a dangerous proximity to the dura mater, being separated by an extremely thin plate of bone, often imperfectly closed by osseous tissue specially along the line of the petro-squamosal suture. Free vascular communication is afforded through this thin partition between the middle ear and the dura, and during any inflammatory process in either, the other is extremely liable to be affected.

It is in these cases of obstructed drainage, especially in children, that severe symptoms develop; periosteal inflammation, both internal and external, with tympano-mastoid abscess and caries of the bone, transforming a simple case into a grave one. As a result of external periosteal inflammation, we shall often observe denudation of bone and caries of the mastoidea, and, when at the same time internal periosteal inflammation extends deeply into the mastoid cellules, perforation of the cortex takes place either through the posterior wall of the canal or through the process behind the auricle (see Fig. 44). Fungosities at these outlets, especially at the former, springing up from the cellules, are usually present and often redundant.

Exfoliation of Sequestra. During the continuance of inflammation of the mastoid cellules, the granulation tissue which fills them and any sinuses leading to the cortex of the mastoid process, into the external auditory canal or into the tympanum, envelops and absorbs minute sequestra. This will not take place while they are immersed in pus only. Furthermore, as a result of the necrotic process established in the cellules, sequestra of various sizes become detached, and may be detected, by the probe, in the diseased cavity of the mastoid. If a free outlet for the secretions is not afforded by the communication with the tympanum or the external auditory canal, a fistulous opening through the mastoid process is formed. Sometimes a large sequestrum presents at the outlet of these drainage-tracts, much to the patient's relief. The carious cavity often gives rise to excessive purulent secretion, when small fragments of bone are carried out of the ear without being observed. Small sequestra carried out along with secretions are doubtlessly sometimes reported as being the ossicles.

Minute seque-tra, embedded in granulation tissue, disappear, as just stated, by absorption, a process similar to the physiological absorption of the roots of deciduous teeth through vascular papillæ.

Injury of the facial nerve, where it passes through the aquæductus Fallopii, may be caused by necrosis or by the pressure of a sequestrum in transit, in which event a facial paralysis would occur. Slight paresis only, however, may result from such an injury to the nerve, the palsy, when not great, being liable to escape notice.

Sometimes large sequestra, consisting of portions of the auditory or tympanic plate or of portions of bone containing the cochlea or semi-circular canals, are removed in these cases, especially in broken-down or scrofulous subjects (see Chap. XV.). It is surprising to witness the rapidity with which recovery often takes place after the detachment of very large pieces of temporal bone.

Among 131 more grave cases of the author's[1] (65 acute and 66 chronic), exfoliation occurred with about equal frequency through the mastoid process and external auditory canal. Of these 131 cases 25 per cent had periostitis externa with abscess over the mastoid process; 23 per cent had tympano-mastoid abscess; 16 per cent had perforative necrosis of the cortex; 21 per cent had caries of the tympanic walls; 14 per cent had facial paralysis; 24 per cent had polypoid tumors.

The results of inflammation of the mastoid cellules are usually either induration or atrophy of the osseous structure. Since the rudimentary cellules of the mastoid in children are, when inflamed, liable to become obliterated, the parts in later years may present dense bony structure instead of cellules.

The temporal bone, like other bones of the skull, is supplied with nutrient vessels both from its outer and its inner surfaces (the dura mater and periosteum). The middle-ear tract is inserted between these surfaces, and has a mucous-periosteal lining of its own. This large space within the bone, divided into larger and smaller cellules, is surrounded for the most part by a very thin shell of bone. There are thus four surfaces, each with its own arterial supply; and this supply is sufficient so that when the periosteum (or corresponding endosteum) is destroyed on one side no necrosis or caries usually results therefrom. Thus either the external periosteum, and the outer layer of the dura mater (which is the internal periosteum), or the mucous-periosteal membrane, or exosteum, lining the entire middle-ear tract, may be destroyed without materially affecting the nutrition of the bone. Inflammation of both internal and external mastoid surface is, probably, usually necessary for the complete destruction of the cortical layer.

[1] Transactions of the American Otological Society, 1886.

Of course, it must be remembered, that all the subjective phenomena, such as vertigo, pain, and so-called brain symptoms, brought about by these pathological conditions occurring in the course of chronic purulent processes of the middle ear, or acute exacerbations of such, are similar in every way to those described with acute purulent otitis media; it is, therefore, unnecessary to repeat them here.

The gravity of these cases does not depend so much on the liability to transmissions of the purulent process to the brain as on the local and constitutional symptoms arising in neuropathic or cachectic persons, especially when subjected to meddlesome treatment. The pernicious effects of over-treatment are seen in a large number of difficult cases, of which the following is an example: A male, 45 years of age, was suffering from an acute purulent inflammation of the middle-ear tract. Severe neuralgic pains were experienced, but there was free drainage. In consequence of the copious syringing and instillation of antiseptic and astringent solutions for the relief (?) of symptoms the discharge was promptly suppressed, and the aggravation was so great that periostitis of the external auditory canal and mastoid process developed. Fluctuation over the mastoid was detected before the drainage was again fully reëstablished from the tympanum. When first seen by the writer, there was intermittent fluctuation; the opening in the drum-head afforded escape for the purulent matter for a day or two, when, on closing, fluctuation would again appear over the mastoid. This alternate collection and escape of matter from the drum was relieved by free incision through the drum-head and over the mastoid, but in the mean time perforation of the cortex of the mastoid process had taken place.

Whether occurring in otherwise healthy or in unfavorable subjects, there is usually a history of this kind or of exacerbation from exposure.

In children the course of purulent inflammation is somewhat different, since the mastoid cellules are wanting, though the antrum is fully developed. Defects in the tegmen are not uncommon, and meningitis and cerebral abscess probably occur more frequently than later in life.

In severe cases (whether so at the beginning or by subsequent aggravation) inflammation of the periosteal lining of the tympanum often extends by continuity of tissue very rapidly, both internally and externally. The exacerbation may or may not be ushered in with a chill, but there is usually elevation of temperature and frequency of pulse.

It often happens, especially in run-down subjects, that all of the

CASE 4.—Male, aged 24 years, with chronic purulent inflammation of the middle ear. Patient was a drunkard, and suffered from tubercular deposits in the lungs. He had been using a nasal douche for the relief of ozena, and this was believed to have caused the acute exacerbation of the purulent process in the ear for which he came for treatment. On examination, it was found that the membrana flaccida was detached and that a dissecting abscess extended from the attic of the tympanum to the mastoid process, which was swollen. Discharge from the canal had ceased. There was pyrexia, and accelerated pulse—124 beats per minute. The patient refused to have the attic opened by an operation, but relief occurred shortly afterwards by a spontaneous rupture of the membrana flaccida. The patient continuing his dissipated habits, disappeared when thus temporarily relieved. It was afterwards learned from the family physician, that he died nine months after this with symptoms of pneumonia.

Facial palsy sometimes occurs during the progress of chronic purulent inflammation of the middle ear, since the inner wall of the tympanum through which the facial canal passes often becomes carious and necrotic, with consequent injury of the nerve. The resulting neuritis may be either an ascending or descending one, the latter often being accompanied by intense pains in the mastoidea and parts contiguous to the course of the nerve. The reader should consult Chapter XV., where facial palsy is treated of more at length. In early life grave, and even fatal, ear disease is of much more frequent occurrence, probably, than is generally suspected. In the two following cases,[1] however, occurring in very young infants, early evidence was not wanting, even to the inexperienced, of serious aural trouble, and death was due to neglect and ill-directed treatment.

CASE 5.—*Otitis media purulenta chronica. Polypus. Facial paralysis. Pachymeningitis. Death.*

Male infant, 6 months of age, was brought to the author's clinic, at the New York Eye and Ear Infirmary, in March, 1884, with the following history:

When 3 months old, he had been exposed to a draught coming through an open window of a railway carriage. A few days afterwards, a circumauricular swelling was observed to take place, which was, by order of the attending physician, poulticed for three weeks continuously. The purulent matter which had been collecting was then liberated by a lancet. After discharging a week, the opening was allowed to close, but subsequently it was again opened and dressed with a tent and some antiseptic ointment. The ear and wound were syringed three times a day with an aqueous solution of

[1] Transactions of the American Otological Society, 1885.

one drachm of carbolic acid to the pint, the solution passing freely through from the wound into the canal. This treatment had been persisted in until the date of coming to the Infirmary. The child's mother thinks two sequestra of considerable size were removed by the syringing about four weeks ago. The discharge, it was alleged, varies from time to time, and is now absent. The child nurses well and sleeps fairly well.

Examination. The lumen of the external auditory canal is obstructed with pus, the removal of which brings to view a large polypoid growth filling the canal. There is partial right facial paralysis.

March 13th. Discharge from the ear and sinus more free to-day, but the child is restless. The polypus was removed with the snare. It was found to be of much greater size than had been expected, filling the tympanum and canal almost to the meatus externus. It was about one-half inch in length, and somewhat nodulated. There was free hemorrhage after avulsion, which was, however, soon arrested by instillations of hot water.

The treatment consisted in gentle cleansing with warm water, as required, afterwards dressing the parts with calendula and boracic acid. Internally, the calcium sulphide, in small doses, was given several times daily.

March 15th. There is diminution in the quantity of the discharge, which is less purulent. General appearance is better, and the restlessness which existed before the operation is less.

The writer did not again see the patient; his mother, however, came several months after to the Infirmary to report his death. She said that the next day after his last visit he became more restless, had a cough, and raised mucus. Vomiting occurred after nursing or taking food or medicine, and continued until death, which took place on April 5th. The child ceased to nurse three days before death, and for two days no discharge from either the meatus or sinus was observed. He had *convulsions* for two weeks, at the beginning of which "his face became straight again" (double facial paralysis), and at the end there was strabismus. These symptoms, taken together with the previous history, point to pachymeningitis. It seems probable that the rapid recurrence of the polypoid growth, blocking up the outlets, and preventing drainage, may have hastened the result. The physician who attended the patient at home certified that he died of "pneumonia, convulsions, and dentition."

CASE 6.—*Otitis media purulenta chronica complicated with lymphadenoma of the neck, resulting in caries of the temporal bone. Facial paralysis. Meningitis purulenta. Death. Autopsy.*

Albert S., a Mulatto, aged 7 months. The patient was brought to the New York Eye and Ear Infirmary in June, 1885, with the following history:

Three months previous to this date, a small swelling appeared in front of the left tragus, coincident with a purulent discharge from the left ear. The swelling extended downward, rapidly enlarging, forming a large, irregular mass, occupying the whole of the left side of the neck. One month ago, the otorrhœa ceased almost entirely, and at the same time the child was taken to a city dispensary, and

placed under local and general medicinal treatment for the glandular tumor.

During this period of treatment the tumor fluctuated in size, a discharge appeared in the right ear, and the child became very restless and irritable, sleeping poorly, attacks of vomiting alternating with diarrhœa; and left facial paralysis was noticed for the first time.

Examination, June 1st. The left meatus was occluded by granulation tissue, which was removed, giving vent to a large quantity of very offensive purulent matter. The canal was dilated, the posterior and inferior walls showing an ulcerated granular surface, the drum-head was entirely destroyed, and the tympanum presented a



FIG. 45.

large cavity caused by the necrotic destruction of portions of the annulus tympanicus and temporal plate, the inner wall of the attic and atrium, the antrum and auditory plate. In a word, the bony walls of the large pathological cavity thus exposed to view were denuded in every direction; the ossicles were absent with the exception of the stapes, which could be seen lying loosely upon the upper and posterior part of the inner wall. The right meatus was filled with granulation tissue which sprouted from the walls of the canal, the drum-head was destroyed, and denuded bone could be detected with the probe in any portion of the tympanum. On the left side of the neck, there were a number of lymphadenomata forming a large, irregular tumor, limited above by the inferior attachment of the auricle,

one drachm of carbolic acid to the pint, the solution passing freely through from the wound into the canal. This treatment had been persisted in until the date of coming to the Infirmary. The child's mother thinks two sequestra of considerable size were removed by the syringing about four weeks ago. The discharge, it was alleged, varies from time to time, and is now absent. The child nurses well and sleeps fairly well.

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The treatment consisted in gentle cleansing with warm water, as required, afterwards dressing the parts with calendula and boracic acid. Internally, the calcium sulphide, in small doses, was given several times daily.

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CASE 6.—*Otitis media purulenta chronica complicated with lymphadenoma of the neck, resulting in caries of the temporal bone. Facial paralysis. Meningitis purulenta. Death. Autopsy.*

Albert S., a Mulatto, aged 7 months. The patient was brought to the New York Eye and Ear Infirmary in June, 1885, with the following history:

Three months previous to this date, a small swelling appeared in front of the left tragus, coincident with a purulent discharge from the left ear. The swelling extended downward, rapidly enlarging, forming a large, irregular mass, occupying the whole of the left side of the neck. One month ago, the otorrhœa ceased almost entirely, and at the same time the child was taken to a city dispensary, and

placed under local and general medicinal treatment for the glandular tumor.

During this period of treatment the tumor fluctuated in size, a discharge appeared in the right ear, and the child became very restless and irritable, sleeping poorly, attacks of vomiting alternating with diarrhœa; and left facial paralysis was noticed for the first time.

Examination, June 1st. The left meatus was occluded by granulation tissue, which was removed, giving vent to a large quantity of very offensive purulent matter. The canal was dilated, the posterior and inferior walls showing an ulcerated granular surface, the drum-head was entirely destroyed, and the tympanum presented a



FIG. 45.

large cavity caused by the necrotic destruction of portions of the annulus tympanicus and temporal plate, the inner wall of the attic and atrium, the antrum and auditory plate. In a word, the bony walls of the large pathological cavity thus exposed to view were denuded in every direction; the ossicles were absent with the exception of the stapes, which could be seen lying loosely upon the upper and posterior part of the inner wall. The right meatus was filled with granulation tissue which sprouted from the walls of the canal, the drum-head was destroyed, and denuded bone could be detected with the probe in any portion of the tympanum. On the left side of the neck, there were a number of lymphadenomata forming a large, irregular tumor, limited above by the inferior attachment of the auricle,

and below by the level of the thyroid gland. No fluctuation could be detected in any portion of the mass. There was complete left facial paralysis.

Treatment. The tincture of aconite, and calcium sulphide were given, the canals being cleansed and powdered boracic acid insufflated once daily. During the next eight days the patient's condition improved somewhat.

June 8th, restless and irritable, with some febrile movement, temperature 102°; frequent vomiting. Discharge from ears free.

June 10th. The patient became drowsy and stupid, had general convulsions; coma supervened, and patient died on June 12th.

Autopsy. The dura mater is healthy, with the exception of that portion covering the superior surface of the left petrous bone, which is much thickened from the deposit of neoplastic tissue, and at points presents isolated centres of ossification.

There is purulent meningitis of the convexity, the deposit of lymph being more particularly noticeable along the margins of the longitudinal fissure, and on the under surface of the anterior and posterior cerebral lobes. The cortical substance is quite soft, and there is considerable accumulation of greenish, offensive matter in the subarachnoidean cavity. No connection could be traced between the ear and glandular enlargement on the neck.

The accompanying cut, Fig. 45, somewhat enlarged, shows the outer surface of the left temporal bone after the specimen had been prepared. The absence of the osseous portion of the external auditory canal at this age brings the inner wall of the tympanum, which is very large, well into view; 1 is the promontory of the inner wall, and just above it is the foramen rotundum from which the stapes has escaped. The inner wall of the attic was gone, exposing the horizontal semi-circular canal. The walls of the antrum and the adjacent cellules were eroded away, and the entire auditory plate was honey-combed. The auditory plate, 5, which was scarcely united to the squamous and mastoid portions, was undergoing sequestration, entirely denuded, and a sinus, 6, afforded communication between the antrum and an abscess beneath the periosteum.

The annulus tympanicus composing the anterior wall of the external auditory canal is shown at 2: it is roughened all around, as is the tympanic plate itself. The rudimentary mastoid process is seen at 3; the under surface of the petrous bone at 4. The squamous portion is shown at 7, 7; the parietal bone at 8, 8.

On the inner surface of the specimen, not shown in the cut, is seen an extensive opening along the line of the petro-squamosal suture through which, probably, the inflammatory process extended to the dura.

It is probable that in this case the inflammation extended itself from the tympanum along underneath the auditory plate into the antrum, whilst a periostitis externa manifested itself on the outer surface.

In reviewing Case 5, it seems remarkable that so little nervous irritability existed during the progress of the case, although the ear

was deeply attacked. With the exception of the last two or three weeks, the child suffered but little, and so far as pain was concerned, it may not have seemed important to the ordinary observer.

To the retention of secretions, the formation of which was actively promoted by the three weeks' persistent poulticing, and perhaps also to the vigorous syringing, was doubtless largely due the gravity of this case.

Middle-ear inflammation in children often gives rise to symptoms well calculated to puzzle the general practioner, and hence its presence is liable to be unsuspected; thus in Case 5, the alleged cause of death as reported to bureau of vital statistics did not include the aural trouble.

The important knowledge to be obtained by observing the phenomena manifesting themselves in the ear in children is not available always without an expert examination; and this becomes a much more difficult matter when exterior manifestations are wanting, since deafness and distressing autophonia, etc., cannot always be explained by children, and never by very young infants, and pain in such cases may be relegated to another region. Although recovery may take place when the aural symptoms are not recognized, yet deafness may remain.

In these neglected cases it is well to remember that the danger does not lie in an invasion of the mastoid cellules, since the mastoid process exists in a rudimentary state only before the age of puberty, but in an extension of the inflammatory process to the antrum, caries of the bone being consecutive thereto. An independent but coincidental attack of periostitis externa may, indeed, take place. Where the latter occurs alone, recovery is usually much more rapid, since, under proper treatment, reabsorption of pus takes place, or it is evacuated by the knife.

Treatment. In the treatment of chronic purulent inflammation of the middle ear, it will be well to consider the cases under three groups, namely: I., those having a tendency to recovery without great loss of the function of the transmitting apparatus; II., these cases in which irremediable impairment of the transmitting mechanism has taken place; and III., grave and complicated cases. In the first-named cases our object should be to restore the organ to as great usefulness as possible; in the second instances, to remove the irremediable and defective structures which interfere either with drainage or the entrance of sound to the drum. The treatment of the grave cases will be considered further on. In accomplishing the above objects, the surgeon should not lose sight of the importance of aiding

the offices of nature in two essential particulars, namely, the maintenance of good drainage from the middle ear and the improvement of the general health of the patient.

The experience afforded by the sometimes grave complications of chronic purulency should admonish the physician not to neglect any of these cases, even when mild. A temporizing, meddlesome treatment of chronic purulent inflammation of the middle ear by local cauterization, astringents, and the like, has justly brought a certain amount of odium or distrust upon this special branch of practice, since it may be continued almost indefinitely without beneficial results, and interrupting, in some instances, the natural tendency to a cure. The surgeon should, therefore, at the onset adopt a rational plan of treatment suited to each particular case, avoiding abusive methods. With the counsel of the family physician, when available,



FIG. 46.—THE AUTHOR'S COMBINATION EAR FORCEPS, having four adjustable operating points, namely: 1. Scissors, for clipping off redundant tissue from the walls of the canal; 2. Serrated Dressing Forceps; 3. Cutting Forceps, for biting off granulatons, etc.; 4. Foreign Body Forceps.

a general course of treatment, including especially hygienic measures, should be insisted on, all causative influences, elsewhere considered in these pages, being, if possible, removed before any local treatment is commenced. The presence of severe nasal catarrh, diseased teeth, etc., if not attended to may prevent any favorable impression from local treatment taking place. These matters having been provided for, the relief of purulency may then be attempted by local measures.

I. Where the mucous tract of the middle ear is the source of discharge, and there is no hindrance to drainage, a cure may confidently be expected from cleanliness alone; and in by far the greater number of cases, healing of the perforations in the drum-head will also take place. Should the perforation, however, show no disposition to

close, its edges may be gently stimulated by some irritant. The insertion of an eyelet, such as has been recommended for keeping perforations open, would afford the necessary stimulation to bring this about. It must be borne in mind, however, that very often the closure of a perforation is followed by a decrease of the hearing power.

Where granulation tissue or polypi have developed in the drum or antrum, they must first be removed before other treatment is attempted. The management of aural polypi will be considered in a separate chapter (XIV.). Granulation tissue is best removed with instruments; cutting forceps and cutting curette may be employed for this purpose. Granulation tissue generally shows a tendency to rapid



FIG. 47.—THE AUTHOR'S GLASS AURAL SYRINGE (half natural size), with hard-rubber tips and mountings.

reproduction, and so long as the general condition of the patient is unfavorable, local treatment is well-nigh useless, reproduction often taking place in a day or two. Where granulation tissue occupies the attic or antrum and cannot be reached with instruments, the insufflation of salicylic acid or the introduction of an ethereal solution of this drug, answers well. The writer, in some cases, employs this remedy in the atrium, especially to the base of masses that have been removed with instruments. The applications should be made daily, or at longer intervals as required. Since humidity is known to favor the growth of granulation tissue, the parts should be kept dry, the ear syringed as seldom as possible, all moisture being gently removed by means of absorbent cotton wound on the end of a carrier. In most cases, the introduction of solutions or powders is harmful, irritating

the mucous membrane only further. They should not be employed unless with the object of transforming the mucous membrane of the tympanum into a dermoid state.

When the general system of the patient is in an unfavorable state scarcely any change may result from treatment for months or years, no matter what methods have been employed.

II. Where a large portion of the membrana vibrans has been lost, with or without ankylosis of some or all of the ossicular articulations, the treatment will consist of measures for the repression of otorrhœa and the removal of polypi and granulation tissue as before alluded to. Our object, however, in these cases will be *to convert the mucous lining of the middle-ear tract into a non-secreting or cicatricial surface*, for it will be no longer possible to restore the formal functions of the transmitting mechanism. We must now endeavor to improve the condition of the parts so as to secure the admission of sound in order that impact may take place directly upon the base of the stapes and the membrana tympani secundaria. After removing any polypi or granulation tissue present, the drum may be packed with drying powders or salicylic acid; the instillation of absolute alcohol in some cases answers better. Granulation tissue may be treated by compression with powdered boracic acid well packed into the atrium, if the membrana vibrans is absent, or nearly so, and the presence of the powder does not interfere with drainage. Where the secretions are putrid, an occasional application of a 45% solution of the peroxide of hydrogen is often beneficial. This treatment, persisted in for a longer or shorter time, may be followed by a cure with fairly good hearing. But often, owing to the persistency of the inflammatory process in regions beyond the atrium, namely, in the attic and antrum, or mastoid cellules, secretions form and are retained, and remedies cannot be applied to the diseased parts; or the presence of the defective mechanism and results of the inflammatory process, such as newly-formed bands, ankylosis of the ossicles, and retained secretions which have undergone inspissation, interfere with the entrance of sound. Under such circumstances the operation of excision of the drum-head and ossicles is to be considered, and will be discussed in detail further on (Chapter XVII.).

Where a sinus exists leading up into the attic, either in front of or behind the short process through the membrana flaccida, the membrana vibrans remaining intact, we may often bring about a cure by thoroughly clearing out the tract, usually filled with thick inspissated pus, granular tissue, etc. The cutting forceps or cutting curette can sometimes be used to advantage in these cases,

being passed up along the sinus far enough to detach any growths. Sometimes a large pathological cavity is thus opened up into the attic, extending even beyond into some of the neighboring cellules. When such a passage has been thoroughly cleared out, the ethereal solution of salicylic acid may be introduced on a small pledget of cotton-wool attached to the end of a silver probe, the parts being afterwards packed with dry salicylic acid. Where a large area, however, consisting of attic and antrum, is secreting purulent matter, such measures are generally ineffectual, and excision is to be considered.

III. Where the mucous membrane of the antrum and mastoid cellules, left in a state of hyperemia as a sequence of acute purulent inflammation, becomes infiltrated as the case assumes chronicity, these cavities have the appearance of being filled with gelatinous matter, as before alluded to. If the mastoid cells now become the seat of caries, with denudation, and the products of the process find no outlet through the tympanum, burrowing through the posterior wall of the external auditory canal or the cortex of the mastoid process will take place, giving rise to urgent symptoms, owing to impeded drainage. In these cases, especially where pointing indicates the course taken by the pent up secretions, we should liberate them by a free opening with the knife.

It is a very difficult matter to decide what course of treatment should be pursued in the early stages of such cases, since a diagnosis is by no means easy. Leaving the discussion of operative procedures on the mastoid with the drill or trephine for the present, the writer will proceed to state what course seems to him best in the cases under discussion.

The following case presents some of the conditions which had best be left to nature, unless the patient comes under observation at an earlier stage of the disease. The patient was a woman, 19 years of age, who had been, probably, the subject of chronic purulent inflammation since childhood, although she had no recollection of ever having had any pains in the ear, or any discharge therefrom, until a short time before she first came; she stated, however, that the ear had had a bad odor at times ever since she was a child. After the removal of a mass of polypi, a large sequestrum was found at the bottom of the external auditory canal, and which, on examination, proved to consist of a large fragment of bone involving the mastoid antrum, some of the pneumatic cells, and a portion of the roof of the tympanum. After these morbid products were taken from the ear, the patient made a rapid recovery. Facial paralysis, however, remained, owing to irreparable injury to the facial nerve.

When, in caries of the mastoid, there is bulging of the integument of the posterior wall of the canal, decreasing the calibre of the latter, the tumefaction having a purplish appearance, and sometimes a minute opening, the parts should be freely laid open. This tumefaction has often been mistaken for a polypus, and futile attempts made to remove it with the snare. It is difficult to keep up drainage, and relief is often temporary only. Grave symptoms, however, generally disappear at this stage, and, indeed, discharge may now occur through the tympanum.

Officious surgical meddling in these cases can but be most injurious, since it is not wise to attempt to separate sequestrating from healthy bone until nature has completed her share of the process.

When the posterior bony wall, periosteum, and integument of the external auditory canal have been perforated in caries, sequestra presenting in this locality can very readily be removed by gentle manipulation; sometimes, however, the canal requires dilatation. It is usually necessary to first bring away the abundant granular tissue which nearly always obstructs the canal, and fills any cavities in the mastoid. The point of perforation in young patients is often very near the outlet, where the surgeon can easily see what he is doing. Where no loose sequestra are found, the case had best be left to the efforts of nature so far as its surgical aspect is concerned, as minute portions of necrotic tissue rapidly pass out when the channel is clear, while a certain quantity is absorbed. In some instances there is reason to believe that sequestra become encysted; of this, however, the writer can offer no absolute proof.

Disease of the pneumatic cells of the mastoid may exist when the appearance of the drum-head gives but little evidence of any middle-ear disease; several instances of this kind have been observed. In one of them an acute and painful attack came on, accompanied by Bell's palsy. The mastoid inflammation did not abate for several weeks, and the palsy lasted much longer. There were no marked acoustic phenomena to indicate disturbance of the conductive mechanism in this case, nor was the drum-head more than slightly hyperæmic for a few days. In another case, where the mastoid disease had existed for years, the perforation in the drum-head closed up, and good hearing returned; the purulent secretions from the mastoid, in the mean time, finding an outlet through the outer table.

Sometimes it is good surgery, when clearing the drainage tract of granulation tissue, etc., to cautiously scoop out the pathological cavern of the mastoid, using care to avoid wounding of the facial nerve. The irritation arising from this procedure is apt to cause a more healthful inflammatory action in the parts.

CHAPTER XIV.

AURAL POLYPI.

According to Schwartze,[1] aural polypi are found in 4% to 5% of all patients with aural diseases, among males twice as frequently as among females. Below is appended a tabulated list, showing the ages and sex in 192 cases of the author's of which records were made:

AGE.	MALES.	FEMALES.	TOTAL.
6 weeks	..	1	1
6 months	1	..	1
Between 1 and 2 years	1	..	1
Between 2 and 3 "	..	2	2
Between 3 and 4 "	..	3	3
Between 4 and 5 "	2	6	8
Between 5 and 12 "	14	15	29
Between 12 and 18 "	22	15	37
Between 18 and 30 "	42	28	70
Between 30 and 40 "	15	10	25
Over 40 years	9	6	15
Total	106	86	192

To the tyro the precise point of origin of polypi is puzzling, and even the expert cannot always determine this at the first examination made. Sometimes they can be seen with the unaided eye presenting at the meatus externus, or, if the canal be large, lying further in. Viewed through the aural speculum they can often be plainly seen to present on the surface of the inner end of the canal or drum-head; but they never take their origin from the skin. When observed coming through the walls of the canal, it will invariably be found that they develop from the mucous membrane lining the cellules which lie adjacent in the mastoid or above the superior wall of the canal, but communicating with the middle ear. Polypi also spring from the openings of sinuses on the canal walls, and which

[1] Chirurgische Krankheiten des Ohres. Stuttgart, 1885, page 211.

afford an outlet to secretions in the attic. When the products of inflammation of the mastoid cellules find an outlet into the posterior wall of the external auditory canal, or through its cortex behind the auricle, the sinus at either of these vents, as a rule, becomes filled with granulation tissue; the former soon sends forth fungosities which may take on polypoid action, since the humidity and warmth of the canal are favorable to such growth; the latter from exposure does not take on such action, though, when freely poulticed, redundant masses of granulation tissue form there.

Polypi do not grow from the dermic layer of the drum-head, but perforations either of the membrana flaccida or membrana vibrans are, towards the decline of acute purulent inflammation, often more or less occluded by the swollen mucous membrane which may sooner or later become the seat of polypoid growth. In such cases the polypi developing exteriorly to the drum-head may become large enough to occlude the canal, though attached to the mucous membrane by a small pedicle whose size is limited by that of the perforation through which it passes.

In the greater number of instances where polypi develop from the mucous tract of the middle ear, considerable loss of substance in the drum-head will be found. The growth may arise from the atrium, attic, antrum, mastoidea, or from the cellules which surround the superior and posterior walls of the tympanum and inner end of the external auditory canal; but in nearly all instances it eventually presents itself to view in the tympanic cavity or in the external auditory canal.

In rare instances polypi are observed to spring from the handle of the malleus, and Burnett reported a case of an organized vesicular polypus which contained the necrosed long process of the incus.[1] Their attachment is as a rule very slight. In one of the author's cases slight traction with the wire snare brought away, however, not only the growth, but also the malleus to which it was attached; it is needless to add, perhaps, that the drum-head was absent in this case. Among 47 cases occurring in the writer's practice, where the point of origin of the polypi was ascertained, it was found that the growth started in the atrium in 26 cases, in the attic in 14 cases, in the antrum in 2 cases, in the mastoid cells in 1 case; was attached furthermore to the handle of the malleus in 3 cases, and to the meatus wall in 1 case.

Polypi are divided according to their structure and nature into

[1] Treatise on the Ear. Phila., 1884, page 501.

mucous, fibromatous, and *myxomatous* varieties. The latter are rarely met with, whilst the mucous variety are the most common of all. The fungosities which spring up from the carious walls of the canal, consequent to perforative inflammation of the mastoid, are frequently very redundant and exceedingly liable to recurrence. They often completely occlude the canal outwardly as far as the meatus.

The size to which polypi may attain is very variable, being from minute and scarcely recognizable growths to tumors the size of a pecan nut, completely filling the canal, and even projecting out into the concha. Where they have long remained, the canal sometimes becomes greatly increased in size by absorption of the osseous substance, and where polypi keep on growing during youth, the canal, in adapting itself to the tumor, is frequently found to be of enormous dimensions.

In some cases the growth is confined to the tympanum by a remnant of the membrana tympani; the middle ear may thus become wholly filled up, or, where only a small perforation exists in the membrane, the growth may make its way through and develop itself in the canal, the pedicle only remaining inside, as in the instance before mentioned. The fibromatous polypi are said to arise from the periosteal layer of the mucous membrane of the tympanum. When they are found attached to the wall of the external auditory canal, they take their origin from some sinus leading into the canal from the pneumatic cells which abound in this vicinity, as above stated. These polypi are very much tougher than the mucous variety, and are much more rarely met with. The clinical history of some cases shows that, on attaining a certain size, polypi detach themselves spontaneously and come away, their place being often speedily occupied by a new polypoid growth.

The symptoms produced by the presence of polypi are numerous and often severe and grave. There will nearly always be found the phenomena due to chronic purulent inflammation of the middle ear, such as otorrhœa, etc., but the presence of the growth generally increases such symptoms, and in addition may give rise to otalgia and other neuralgic symptoms, facial paralysis, deafness, autophonia, vertigo, and nausea, offensive odors from the decomposition of pent-up secretions, hemorrhage, caries and necrosis of the bony structures, and often meningitis, resulting in death.

The *otalgia* and other neuralgic symptoms are, in great part at least, due to the pressure of the tumor, especially when coincident with an exacerbation of the otitis media.

The *vertiginous phenomena* seem to be due, in these cases, either to the increase of labyrinthine pressure, the more direct cerebral

pressure through the tegmen tympani, which is often thinned by previous absorption, or to the irritation of the chorda tympani.

Facial paralysis is not unfrequently the result of the pressure of the neoplasm upon the facial nerve at some part of its course in the neighborhood of the tympanum. It occurred in five of the author's cases given above. This subject will receive more attention in Chapter XV.

Deafness will, of course, be always more or less increased by the occlusion of the external auditory canal, and by the interference with the transmitting mechanism, when an effective portion of it remains.

Tinnitus aurium and *autophonia*, phenomena of frequent occurrence in otitis media purulenta, are increased very often by the presence of polypi in the tympanic cavity. These acoustic symptoms are probably much more pronounced where the transmitting mechanism is not greatly impaired, but the growth itself may perform the functions of transmission in the same manner as an artificial drumhead.

The offensive odor, present in most cases of otorrhea of long standing, is often very much increased by the stoppage of the canal by the growth; in some instances the matter finds an outlet from the tympanum through the Eustachian tube into the pharynx, when the breath of the patient will be found to be very offensive. It will doubtless occur to the reader that, in such cases, there would not only be increased danger from absorption of the purulent secretions, but that the constant inhalation of depraved air would likewise be injurious.

Hemorrhage, although scarcely ever profuse, is of frequent occurrence, since slight injury, as from syringing or probing, may wound the growth; indeed they very often bleed without any assignable cause.

Although *caries and necrosis* can scarcely be considered as due to polypi alone, yet when the bone is already affected, an extension of the process may be thus brought about.

Meningitis sometimes occurs, as a consequence of the pressure caused by the impaction which takes place when acute middle ear inflammation supervenes during the presence of a polypus in the tympanum. The writer has met with instances of this kind, one of which, at least, was fatal. In these cases the tumor itself seems to be increased in size. In one case where a patient came to the infirmary suffering from pain, insomnia, and other symptoms due, it was supposed, to pachymeningitis, relief was afforded by removing a large

amount of polypoid growth from the tympanum and antrum mastoideum; recovery was slow, and though the patient was finally discharged, his mind at the time was affected. In still another case, where the patient refused to submit to an operation for removal of a polypus which troubled him, pachymeningitis, believed to be due to the pressure of the polypus upon the tegmen tympani, developed, with hallucinations, suicidal mania, etc. The patient died soon afterwards from maniacal exhaustion.

The following cases illustrate well the history and course of the disease.

Measles. Otitis media purulenta chronica. Otalgia. Brain fever. Polypus in both ears.

Female child, aged 11 years. Seven years previously had measles, followed by frequent attacks of otalgia. Eighteen months since she had had "brain fever" for three weeks, with discharge from the left ear, which still continues. Three weeks ago the right ear also began to discharge, without previous or subsequent pain.

Examination showed a polypoid growth in the left tympanum. In the right ear a polypus was seen attached, seemingly, to the short process of the malleus, and rendering the drum-head indistinguishable.

Measles. Otitis Media Purulenta Chronica. Neuralgia. Autophonia. Tinnitus. Catarrh of the upper-air Passages.

Irish domestic, aged 16 years. During an attack of measles two years ago she took cold, otitis media purulenta of the left ear ensuing. Discharge continues until the present time, accompanied by great deafness. One year ago, during the winter, she contracted a bad cold by going out of the house with bare feet. Since then there has been almost constant pain, occasional tinnitus in both ears, and weekly neuralgic headaches. No vertigo, but occasional autophonia. Patient is subject to attacks of naso-pharyngeal catarrh. There has never been any discharge from the right ear. Menses are regular and normal, and general health fair. Examination shows a polypus occluding the left external auditory canal to the orifice. This polypus was removed with the snare, and daily insufflations of boracic acid ordered. Improvement in hearing followed this procedure, and the chronic suppurative process healed shortly under this treatment.

Treatment. From the cases presented it will be seen that escharotics are not employed, but that when the growth is of sufficient size to be engaged in the loop of the aural snare, that instrument is always first employed. The first steps to be taken, however, are to lightly syringe the ear, and afterwards carefully dry the parts with absorbent cotton-wool wound on the end of a carrier; then ascertain, if possible, by careful probing, the exact point of attachment of the pedicle, since most aural polypi are pediculated. Gentleness is urged in the above procedure, for polypi bleed very readily

when handled, and the presence of blood interferes with the operation. The loop of the polypus snare should be made large enough to just pass over the tumor and then be slowly carried down to the seat of attachment, when the wire should be tightened as much as possible without breaking.

Fibroid polypi will generally resist the cutting action of the fine wire now generally employed, on account of its hardness, in place of the stouter silver wire; it will be well, therefore, when it is evident that the wire will make but little or no impression, to make firm trac-

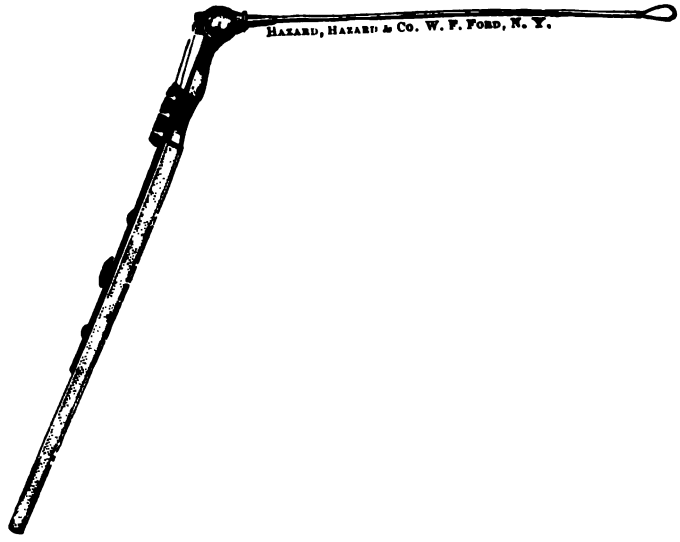


Fig. 48.—The Author's Polypus Snare.

tion upon the tumor and complete the operation by evulsion. In such cases it will usually be found that none of the tumor is left.

Mucous polypi are most easy of amputation. Sometimes several efforts will be necessary before the entire mass is brought away. When any portion is left, it should, as a rule, be removed by the biting forceps or a cutting curette. Where several polypi exist in the same canal, they should all be removed at one sitting if the patient can endure so much, for anesthetics are seldom employed in this operation, unless it be in the case of children or for the detachment of fungoid tissue.

Hemorrhage is rarely profuse after the operation, but when it occurs it may be promptly checked by gentle syringing with *hot* water.

After the removal of polypi, the writer has found by experience that it is not necessary to use such severe measures as the application of strong caustics to the base from which the tumor sprung. Superficial caustics, as a rule, are inefficient, while searching ones cannot be controlled and may produce serious trouble in surrounding structures. The parts should after every operation be dressed by insufflation of pulverized boracic acid or salicylic acid. In certain cases the employment of alcohol after the operation is beneficial. Strong alcohol may be instilled, several drops at a time, and allowed to remain for a few minutes. It may be applied several times daily, and in some instances the parts do well if afterwards dressed with one of the powders above mentioned.

Fungosities springing up from the external auditory canal where a communication exists with diseased mastoid tissue should be removed with the biting forceps and the canal afterward dressed with powdered boracic or salicylic acid. This dressing should be repeated daily by the surgeon himself, and by the patient during the interval until the improvement begins, when the application may be made less frequently.

CHAPTER XV.

FACIAL PARALYSIS DUE TO AFFECTIONS OF THE E AND CONTIGUOUS PARTS.

Bell's palsy, as this affection has also been called, is a not in quent sequence of disease of the facial nerve in its passage thro the temporal bone. It may be caused by intercranial disease eit at the source of the nerve or at some point along its course be entering the temporal bone; by necrosis of the labyrinth; by infl mation of the middle ear near which the facial canal passes in course, and by exposure of the nerve to cold after its exit from stylo-mastoid foramen. Facial paralysis may also arise from trau fracture of the base of the skull, etc. Allusion to this trouble been made in discussing acute and chronic inflammation of the mid ear, syphilis, etc.

The author has records of 32 cases seen in his own practice, males and 11 females. The two youngest were males, aged 6 7 months respectively; two males and one female were 2 year age, and one female was under 3 years of age. Five patients w between 5 and 10 years of age; three were between 10 and 20; se were between 20 and 30; four between 30 and 40; five between 40 50, and two between 50 and 60.

Etiology. In sixteen of the author's cases paralysis of the fa occurred during the existence of acute inflammation of the mid ear; in seven cases during the progress of chronic purulent infla mation of the middle ear, either as a sequence of an acute exacer tion of the inflammation or due to exposure, draughts of cold etc.; two occurred in connection with subacute inflammation of middle ear from exposure; one was due to gunshot wound of drum (see case of Lieut. Simms, p. 154), and one to fracture of base of the skull, causing also purulent inflammation of the mid ear. Syphilis was the cause in four cases; in none of these was th any purulent process or caries of the bone, the paralysis being d to central disturbance or perineuritis of the facialis.

The impaction of polypi, owing to swelling of the mucous membrane about the growths themselves, and possibly to their enlargement also, seemed to have been causative in a greater or less degree in five cases. Caries and necrosis of the bone accompanied in numerous instances the inflammatory processes of the middle ear; in eleven cases, namely, there was caries of the mastoid, in three there was caries of the tympanic and auditory plates. In five cases, furthermore, necrosis of the labyrinth occurred, in three of which the cochlea, as shown by the sequestra, was involved.

Diseased teeth, especially the retention of teeth which had been filled after destroying the pulp or "nerve," and the difficult eruption of wisdom teeth, exerted a very decided influence in a considerable number of cases; steaming and poulticing the ear excessively for the relief of earache was the predisposing cause, without doubt, in three cases. In most of such cases the immediate excitant was exposure of the sensitive region about the ear to draughts of cold air. It would seem, namely, that where the nerves are made over-sensitive by excessive poulticing, reflected irritation, and the like, or from prolonged excitation from any cause, giving rise to exhaustion, the susceptibility to neuritis is increased, and slight exciting causes may give rise to facial paralysis. In regard to the side affected in the cases above enumerated, the following observations were made. Nineteen were affected on the left side, eleven on the right, and two on both sides. Among the males the right side was affected in ten, the left in nine, and both in two cases, whilst in females the left side was affected in ten and the right in one case. The more frequent occurrence on the *left side* is notable; the same tendency on the left side is also noted in connection with chronic non-purulent inflammation of the middle ear and in othæmatoma.

Symptoms and Course. The appearances of the face when the functions of the facial nerve have been impaired are well shown in the accompanying illustrations, one a single and the other a double facial paralysis. The cases cited below are so illustrative that a detailed account of symptoms may be omitted here. Attention, however, is invited to the nervous and acoustic disturbances, as pain, vertigo, neuralgia, noises in the ear, and autophony which were present in these cases. These made a group of symptoms as puzzling as those known under the unscientific name of Ménière's disease.

The degree of deformity, depending on the extent of injury to the nerve, is slight in some cases, and detected with difficulty, whilst in other instances it is very great. The writer has noted, for example, cases where, from the history, the trouble was unknown to the patient

himself although existing for many years. The patient, however, usually observes the peculiar loss of motion of the muscles of the one side of the face in laughing, whistling, or in masticating food, etc. Where the paralysis is due to middle ear disease affecting the facialis before the chorda tympani is given off, there will be found a partial loss of taste in the anterior two-thirds of the tongue, on the same side; this may not be noticed by the patient until his attention is directed to the matter. Where the cause of the paralysis is central, we may find that the patient retains the ability to raise the eyebrows, since the temporo-facial branch supplying the occipito frontalis muscle has its origin remote from the roots of the *portio dura*. Spasm of the facial muscles from the physiological effects of strychnia or other cause may be mistaken for facial palsy; the writer once saw a case of spasm due to large doses of nux vomica, in a patient with chronic inflammation of the middle ear, where, before the real cause was discovered, Bell's palsy had been suspected.

The course of facial palsy depends on the nature of the primary affection; where it appears in the course of an otitis media of a mild type, or arises from cold or the impaction of a polypoid growth, the palsy disappears, as a rule, very soon. Removal of the cause will usually be followed by the disappearance of the trouble. In a considerable number of instances, however, recovery is incomplete, and more or less disfigurement remains during life. It has been stated that facial paralysis is sometimes due to intra-tympanic pressure caused by polypi or pent-up secretions; in two cases of the latter observed by the writer, the symptoms disappeared after evacuation of the fluids, in one instance through the drum-head, and in the other through the sac of a tympano-mastoid abscess. In another case due to impaction of an inflamed polypus in a broken down subject suffering from an exacerbation of chronic purulent inflammation occasioned by exposure, the auditory plate became carious, the cochlea was exfoliated, and came away in a sequestrum. After this, recovery was rapid and considerable hearing remained for musical tones and conversation.

The following cases illustrate the symptoms, course, and termination of the trouble.

CASE 1.—*Chronic Purulent Inflammation of the Tympanic Attic and the Mastoid Antrum. Exacerbation from Impaction of Polypus. Facial Palsy. Pachymeningitis. Death.*

J. G., a merchant, aged 46 years, was first visited at his residence on June 3d, 1879. Patient gave a neuropathic ("malarial") history, and was suffering from nervous exhaustion due to the strain attendant on a series of unsuccessful business ventures during the past nine years. He has had a discharge from the left ear since childhood, and

when living in England was taken by his father to London to see Mr. Toynbee. Of late years a "fleshy" growth presenting at the left meatus has been noticed. He stated that four weeks ago the discharge ceased, and he was taken with severe pain in the ear, extending to the mastoid process and side of neck and face. About ten days ago all of the symptoms increased in severity, and the left side of the face became paralyzed. Leeches and poultices were applied without giving any relief. During the past two days the escape of pus and blood from the pharynx seemed to point to drainage through the Eustachian tube.

Examination. The inner extremity of the external auditory canal is completely occluded by an impacted polypoid mass. There is left facial paralysis. There are a number of carious teeth in the lower jaw, together with a heavy collection of tartar. He complains of photophobia and vertiginous phenomena; the pulse and temperature are almost normal.

Treatment. The polypus was removed with a snare, and the patient was placed under appropriate constitutional treatment. During the next month there was, however, no improvement in the symptoms, the patient continuing to lose ground, although the drainage from the ear was unobstructed. There were at times severe exacerbations of pain in the head and ear with vertigo and vomiting. After the twenty-seventh day the patient grew rapidly worse, agonizing pain in the head and vertigo were constant, diplopia and muscular spasms of right side of face appeared; he was unable to swallow or voluntarily empty the bladder, became comatose, and died July 11th.

In this case, after the cerebral symptoms set in, and after establishment of free drainage, there was no further increase of the inflammation of the middle ear tract, nor was there any periostitis externa.

CASE 2.—*Facial paralysis of the right side, caused by necrosis of the petrous bone, occurring in a case of chronic purulent inflammation of the middle ear.*

See Figs. 49 and 50 (from photographs), showing the patient in repose, and the same patient endeavoring to laugh.

Patient was a woman, 19 years of age. When about ten years old she experienced buzzing in the right ear. Coming for treatment in November, 1880, she stated that the ear never discharged until six months previously; commencing after "pains and a gathering" in the ear. Four months ago she had a severe cold in the head, and one week afterwards she found, on getting up in the morning, that the right side of the face was paralyzed; the mouth was drawn to the left, and she was unable to close the right eye. She was not suffering pain when she came for treatment, but previously she had suffered much from neuralgia in the right temporal region, perhaps partly from dental caries. For the past four months the attacks have been of a more distinctly paroxysmal character. For the past two months she was never free of vertigo, and was in constant fear of falling backwards; her gait is staggering. When pressed for a statement respecting the duration of the aural disease, she admitted that the ear had always had a bad odor.

On examination, a large polypus was seen to almost fill the right external auditory canal, and the probe detected the presence of a detached sequestrum of bone deep in the canal. The polypus, which was attached to the superior-posterior wall of the canal, near its outer extremity, was removed by the snare, and the sequestrum was immediately afterwards brought away by the foreign-body forceps. The latter came away with difficulty, although the external auditory canal was, fortunately, very large. The sequestrum, when examined, proved to consist of a plate of irregularly rounded bone about one-fourth of an inch in diameter, one portion of which was very thin, and the other nearly a quarter of an inch in thickness. This sequestrum con-



FIG. 49.



FIG. 50.

sists probably of the roof of the tympanum and a portion of the mastoid body just external to the hiatus Fallopii. A ridge on the specimen corresponds to the anterior ridge of the groove on the superior border of the bone located beneath the superior petrosal sinus. The reticulated arrangement in the cavity of the specimen has the general arrangement of the reticulæ of the antrum mastoideum; besides which, the relations of the compact and cancellous tissues are such as to exclude its having been located elsewhere. The superior surface of the sequestrum, where it came in contact with the dura mater, was roughened by caries.

After the removal of the sequestrum, another large polypoid mass

was taken away from the ear, leaving a very large cavity at the junction of the canal and the posterior wall of the tympanum.

At the bottom of this cavity was a mass of granulation tissue, which, under the use of powdered acidum boracicum, soon disappeared, and the discharge ceased. The facial nerve, when tested, did not respond to either galvanism or faradism, although, at first, the muscles of the face gave degenerative reaction.

In this case, the facial nerve was undoubtedly impaired before the chorda tympani was given off, for there was very decided modification of the sense of taste on the right side of the tongue. The palate was unaffected. The palsy has been treated by the galvanic current, but with slight improvement. Hearing was not entirely lost. The patient is at present free of vertigo and tinnitus aurium, but has occasional headaches, owing to a rather run-down condition, and the continuance of oral and naso-pharyngeal irritation.

CASE 3[1].—*Bilateral facial paralysis occurring in a case of sudden deafness from syphilis.*



FIG. 51.



FIG. 52.

See Figs. 51 and 52 (from photographs), showing the patient in repose, and the same patient endeavoring to close the mouth and eyes.

[1] Cases 2 and 3, with the accompanying illustrations, were published in The Illustrated Quarterly of Medicine and Surgery, Vol. I., No. 1, January, 1882.

This patient was a man, 40 years of age, who had contracted syphilis in the summer of 1879, and was treated in Charity Hospital. Three months later, having taken a severe cold, he had paralysis of the *right* side of the face. Three months after this attack, and six months subsequent to the syphilitic infection, he was again very much exposed in a cold rainstorm, and went to bed with a severe cold; on getting up the following morning he experienced so much vertigo that he could only walk with difficulty. While eating his breakfast, he found that he could open his mouth only wide enough to admit a spoon between his teeth. A facial paralysis of the *left* side had now occurred, and the inability to get food into the mouth was owing, doubtlessly, to the unique employment of the unaffected muscles used in mastication.

The patient at this time experienced severe pains in the right side of the head. Soon after the experience above related, as taking place at breakfast, while trying to converse with a friend, he found himself to be perfectly deaf in both ears, and since then he has been unable to hear a single word, however loudly spoken. The patient las not conscious of any deafness following the first attack of paraysis on the right side.

When the patient first experienced difficulty in opening the mouth, he fancied that he had "lock-jaw," and he then ascertained that instead of the face being drawn to the left, both sides were now alike. Following both these paralytic invasions, he experienced distressing tinnitus aurium, which continued up to the time he was seen—some eighteen months after the initial attack. He also suffered greatly from pains in the head and vertigo until a short time before the writer saw him. He could not, of course, either whisper or whistle. No treatment was attempted.

The view of this patient, when the face was in repose, gives the characteristic facial expression in this affection; the eyes have a horridly staring look, while the entire face is an expressionless blank. When trying to explain the symptoms of his case, the difficulty experienced in enunciation, together with the nasal tone and collapsing of the nostrils—the latter preventing the entrance of air into the nose—caused the patient to exert himself in a most painful manner, yet the face gave no evidence of the struggle taking place. The absence of nearly all of the teeth rendered articulation still more difficult. When an effort was made to close the mouth and eyes, the former was accomplished by the action of the temporal, masseter, and internal pterygoid muscles; the patient was, however, inclined to use his hand when requested to bring the jaws together. It was not possible to close the eyes, but he was able to roll them upwards and inwards, the lower lid remaining inactive, the upper lid dropping down slightly by its own weight; the effect of the display of the lower portion of the cornea between the widely separated lids was ghastly in the

extreme. Fortunately for these cases, the levator palpebræ not being supplied by the facial nerve, the upper lid can be raised from the eye.

The cause of the paralysis in this case is somewhat in doubt. There is a strong probability that the morbid process which gave rise to it was at the base of the brain; if so, it was probably syphilitic. The fact that the patient had lost control over the fronto-occipital muscle pointed to a central lesion. There are some reasons, however, for believing that peripheral causes also existed, the most important being the aural symptoms; the attacks followed colds, during which there were pains in the neighborhood of the ear and disturbances of the functions of both the transmitting and perceptive regions of the ear. The exact seat of the peripheral lesion, if any, cannot be told, for there were but slight morbid changes in the ear perceptible to the eye, and the patient did not return again to have the sense of taste, etc., tested.[1]

CASE 4.[2]—*Complete facial paralysis occurring during an attack of subacute catarrhal inflammation of the middle ear. Severe head cold. Irritation from a dead tooth.*

Patient was a seminarian, 40 years of age, who had always been subject to head catarrh and, of late years, to neuralgia from irritation of defective teeth. General health not good. His present trouble began about four months ago, when the amalgam plug in the lower right second bicuspid tooth became loose, and was replaced by a dentist after the pulp and nerve had been removed from the tooth, leaving it in a diseased and sensitive condition. Patient was much run down at the time by hard work. On Christmas morning he got up feeling badly from an exacerbation of head catarrh. During the church service he perspired freely under the heavy vestments worn, and stood in a draught of cold air from an open window with uncovered head and right side of neck. An attack of subacute aural catarrh followed this, and severe neuralgic pains, starting in the right mastoid and extending down the neck and over the temporal region. On the second day after this, complete facial paralysis of the right side developed. Pain in the right mastoid was so severe as to mask other symptoms, and patient was confined to his bed for three weeks. For several weeks after getting up the paralysis was treated with the faradic and galvanic currents, and the ear blistered.

The author first saw the patient about three months after the trouble began. Patient was then weak and nervous, and very considerable paralysis of all the muscles of expression remained. From the first there has been considerable swelling on the jaw over the region of the dead tooth, and hyperæsthesia of the skin of right cheek. The drum-heads showed but little of the effects of the recent

[1] For other features of this case, especially as regards the hearing, see American Journal of Otology, vol. ii., p. 304.

[2] Medical Record, June 19th, 1886.

catarrhal inflammation. Hearing in right ear almost normal; but in the left only loud voice was heard.

On extraction, the tooth giving rise to the irritation of the inferior dental nerve was found to have its pulp-cavity carelessly filled with amalgam, its canal being loosely packed with cotton-wool down to within a quarter of an inch of the apex. The alveolus was in a state of inflammation.

The anomalies of audition were particularly interesting, owing, it is believed, to the paralysis of the tensor tympani, stapedius, and tensor palati muscles, which derive their motor nerves from the facial, since it is through these muscles that tension of the transmitting mechanism of the ear is maintained. Since the paralysis came on, his own voice is unnatural to himself; it echoes in the right ear. Sounds emitted from the movements of heavy trucks, coal rattled in a sheet-iron vessel, the larger pipes of an organ, etc., give rise to a second impression of sound which is perceived in another key altogether, and resembles the rattle of the cords of a snare-drum. This supplementary phenomenon, known as acousis duplicata, or double hearing, is due to cognizance being taken of vibratory movements of the drum-head itself, which occur independently of the rest of the transmitting mechanism, *i. e.*, without causing excursive movements in the chain of ossicles. Autophonous phenomena were experienced in the left ear, due to the loss of tension from cicatricial transformation.

On reviewing the history of this case it would seem that the nerves affected by the dental irritation were in an exhausted state, favorable to neuritis, and that the facial nerve, which lies in the inner wall of the tympanum, was especially liable to become affected through extension of the inflammation of the middle ear present. It is difficult to say whether the exposure to the draught of cold air or the middle-ear disturbance first gave rise to the nervous trouble; in other words, we cannot tell whether it was an ascending or descending neuritis. It seems probable, however, that but for the presence of the dead tooth the patient might have escaped the facial paralysis, since non-suppurative inflammation of the middle ear is not liable to extend itself to the facial nerve; even the much-exposed *chorda tympani* seems seldom to be affected. There was in this case no alteration in the sensation of the tongue.

We are not left in doubt as to the peripheral origin of the paralysis in this case, since the temporo-facial branch supplying the occipito-frontalis muscle was involved, and its fibres are believed to have a central origin, remote from the other roots of the *portio dura*.

The value of pain in the mastoid as a symptom in differential diagnosis is well shown here. Intense and prolonged pain was experienced, due to the neuritis alone, in all probability, and hence the operation of trephining the mastoid for the relief of inflammation of the antrum or cellules would have been inadvisable.

The following case is one showing great similarity with the foregoing:

CASE 5.—*Facial Paralysis due to severe Head Cold as an exciting Cause, and the great Irritation from a "dead" Tooth. Chronic Catarrhal Otitis Media. Syphilis. Recovery from palsy in fourteen days.*

Patient, a male, aged 27 years, with good general health, was first seen by the author on October 17th, 1887. Patient had suffered for two months in 1882 with severe bronchial catarrh, and had always been afflicted with catarrh of the head. He has been slightly deaf for several years, but three years ago the deafness became especially marked in the left ear. Two years ago he contracted syphilis, and was kept for a whole year under full doses of mercury at the point of salivation. His teeth have long been defective. One year ago a "dead tooth," the left upper first bicuspid, was filled by a dentist. About four months since a sudden "roaring noise" began in the left ear, after a sea-bath, and has continued ever since. This was treated by vigorous syringing of the ear two or three times daily. Two weeks ago he began to experience a giddy feeling at times, with nausea; he fell from his chair at the table one day. Since this time he has also experienced headaches in the left side, extending over the forehead of the same side, and, furthermore, an occasional pain in the left ear. Three days ago, whilst at sea, took a severe head cold from exposure. He states that the cold settled about the angle of jaw under left ear. The left facial palsy was first noticed yesterday. He cannot spit, close the left eye, or whistle. Mouth drawn to right side. There is very decided head-catarrh. Patient is much run down in health, and vertiginous. Tinnitus annoys him greatly. Hearing in left ear for loud voice only at five feet distance; in right almost normal. The region above the angle of jaw and under auricle on left side are sensitive to the touch. To have "dead" tooth removed.

October 18th.—Had "dead" tooth drawn yesterday, both roots being found diseased, with an abscess in the jaw. Another carious and filled tooth, on the right side, was also removed. Pain about the angle of jaw very severe to-day.

October 19th.—Pain and tenderness now well realized at the exit of the facial nerve from its canal. Patient did not obtain any sleep during the past night. During the exacerbation of pain the paralysis seems to be increased.

Veratrine ointment ordered, and 5 grains of quinine every afternoon.

October 20th.—Pain less, as is also the paresis. Slept well last night. The hearing in the left ear has improved somewhat. Calcium sulphide and tinctura ferri.

October 22d.—No pain. Paralysis the same. There is some congestion of the conjunctiva of left eye.

October 24th.—General condition improved. Conjunctivitis much less.

October 26th.—Palsy almost gone. Some slight amount of tenderness still remains at the angle of jaw on left side and under auricle. His general health has improved greatly, and the slight vertigo felt occasionally up to this time has disappeared.

October 29th.—Great improvement in condition. Palsy almost absent.

October 31st.—Palsy entirely gone. No pain or tenderness in or about auricle and jaw. The tinnitus now resembles "escaping steam."

Prognosis. In a large number of instances this is favorable. In the 32 cases observed by the author the termination was as follows: In 4 cases recovery took place in from a few days to two weeks; 6 recovered in from three weeks to two months; 5 recovered in from two to three months; 2 inside of one year; 2 inside one year and a half. The result was unknown in 8 cases, and 5 cases died from the effects of the aural trouble.

Of the 4 syphilitic cases the palsy was double in 2 and permanent; in 1 there was great improvement, in the other the result is unknown. Of the 3 cases of cochlear exfoliation 1 gradually recovered in the course of eighteen months; 1 improved greatly and the other but slightly.

The distortion of infantile palsy usually disappears as age advances, but in some cases it remains to more or less extent through life.

Treatment. Our attention should first be directed to the cause. It goes without saying that, in addition to the treatment of the ear itself, polypi, sequestra, granulation tissue, pent-up secretions, or any foreign body in the tympanic cavity should be sought for and promptly removed. In the writer's experience, oral irritation often stands in the relation of a remote or indirect cause, and the happiest effect has often been observed to follow the extraction of a wisdom tooth (usually the lower one on the same side), the eruption of which is difficult, or a tooth the pulp of which has been destroyed and afterwards filled. For the pain about the mastoid and down the side of the neck or in the temporal region, the application of veratrine ointment, used several times a day, is often beneficial. Usually the employment of the bisulphate of quinine or the tincture of the chloride of iron is indicated. The writer prefers to give the former in from one to three grain doses, three or four times daily; the latter in elixir simplex, as a menstruum, in doses of five drops, well diluted in water, after meals. The importance of out-door exercise and other

hygienic measures is to be kept in mind. Poultices and steaming are to be avoided as a rule, since we find that their excessive employment has been the principal predisposing cause of facial palsy in several instances. Electricity has been highly vaunted in such cases, but the author has never been convinced of the advantages claimed to arise from the employment of this agent. For the neuritis itself the galvanic current is recommended, and for the restoration of power to the facial muscles the faradic current is employed. This latter has, it is thought, been of advantage in some instances. It has been recommended to hold the affected side of the face in position by inserting a wire bit, shaped like a fish hook, in the corner of the mouth, tension being maintained by attaching the bit to the auricle of the corresponding side of the head. This may be attended with more or less comfort to the patient, but we must not forget that any measure interfering with the action of the muscles, like the use of shoulder braces, weakens them from disuse, rather than strengthens them.

Central lesions cannot well be reached, though in syphilis the remedies suggest themselves to every one, namely, the mercurials and iodide of potassium. The author's practice is to give these remedies in much smaller doses than are usually employed.

CHAPTER XVI.

ANOMALIES OF AUDITION.

Noises in the ear. Autophonia, pseudacousma or false hearing. Effects of false hearing on Singers, Actors, Lecturers and Musicians. Certain other anomalies of audition. Dysacousma or painful hearing. Some of the relations of certain aural phenomena, hallucinations, etc., to Insanity and Brain Affections.

If we accept the conclusions that seem fairly admissible from a study of the anatomy of the sound-transmitting mechanism of the ear, the performance of its normal physiological functions, and its anomalous action under the pathological conditions described somewhat fully in another place (see Part I.), we shall find ourselves at variance with the views held by some writers respecting the part performed by the transmitting media of the middle and inner ear respectively. Further scientific research may, of course, increase our knowledge of this subject, and the writer cannot, therefore, presume to advance any hypothesis as other than tentative. It is believed, however, that, in consequence of misleading physiological theories, whereby pathological acoustic phenomena—due to disturbances in the middle ear—have been relegated to the labyrinthine or cochlear mazes of the inner ear, progress in the field of aural clinical research has been much retarded.

The auditory nerve is considered by physiologists as belonging to the class of nerves having special functions, and as being in the ordinary sense in no way either sensory or motor. It is doubtlessly specially adapted to the mode of motion which sound assumes in the course of transmission from the middle ear to the perceptive centre of the brain, or auditory tract; but it is well known from clinical experience that irritation of the middle ear, as in operations upon this region, or the injection of water, even when the drum-head is intact, or from impressions propagated in some remote region of the body, and transmitted along the course of the facial, chorda tympani, or other nerves, may give rise to vertiginous phenomena. The terminal

filaments of the portio mollis doubtlessly seldom take cognizance of impressions other than those due to aërial impact of sound normally transmitted. Yet as we all know, sound is but force in motion, and when the middle ear mechanism is absent or defective, its impulses may give rise to cerebral shock. Indeed, it is probable that an anæmic condition of the individual may lessen the drum's tension, as in sea-sickness and the like, so that oscillations of the drum-head, occasioned by heavy sounds imparted from the motions of the waves and the ship, would give rise to dizziness and other phenomena.

The mode of sound transmission, where hearing does not take place through the transmitting mechanism of the middle ear, or does so imperfectly, is of the greatest interest to otologists. In normal hearing it would not seem to be transmitted by means of molecular changes in the osseous tissues of the chain of ossicles, since they do not offer an unbroken continuity; but it may reach the perceptive centre through the walls of the drum or even from the tissues of the head from all directions, as for example, when a vibrating tuning-fork is held in contact with the skull or teeth. The sensory nerves of all parts of the body likewise convey to the brain vibratory sensations, but such impressions are described as being usually *felt* only, unless the undulating movements are taken in some degree by the transmitting mechanism of the middle ear. Advantage may be taken of this fact to aid the defective hearing sense by means of a vibrating fan or the like held against the teeth.

In respect to *the significance of the transmission of sound to the ear through the tissues in aural disease*, it may be said that so long as the parts of the ear concerned in sound transmission remain in a normal state, sound almost exclusively reaches the auditory nerve by means of their action, and since impulses of sound are thus practically excluded from all other channels (tissues) of transmission, the confusion which would otherwise arise is avoided.

Disease, however, may give rise to changes in the transmitting mechanism, owing to which vibratory impulses are but imperfectly conveyed in the natural way, *i. e.*, by aërial conduction, and then it is that the auditory nerve takes cognizance of sounds hitherto excluded from it by the peculiar arrangement of the transmitting apparatus; these unpleasant and strangely sounding undulatory vibrations are received through the osseous, muscular, and other tissues, the contents of the blood-vessels, and the Eustachian tube when patulous.

The altogether anomalous hearing, which may exist for a time continuously, or may be interrupted, as it were, by almost normal hearing, is dependent for the most part on the passage of sound to the ear,

through both aërial and tissue media at the same moment. Owing to the increased intensity of sound, thus partly heard coming through the conducting medium of the tissues, an extremely confusing and disagreeable effect is produced, and the definition of an exclusively aërial transmission is wanting.

As is well known to otologists, hearing may thus become a very painful experience; if the patient then hears his own voice autophonously, he feels that it has been much altered, or is not intelligible to others; indeed, it is almost unrecognizable to himself even. The discomfort may be increased, if such a thing be possible, where the physical and mental distress is almost unbearable, by the tinnitis aurium arising from the circulatory movements taking place near enough to the ear to be heard. Loud noises, such as the passage of railway trains, street trucks, the action of machinery or the like, owing to the better transmission of their more profound impulses through unaccustomed media of approach, fall upon the nervous centre of audition like a blow, and thus give rise to dysacousma.

It being doubtful if the perceptive sense of hearing be increased by labyrinthine inflammation, we may suppose that so-called hyperæsthesia of the auditory nerve consists in the painfulness of the impression made by sound on the perceptive centre. If this be true, inflammation of the perceptive filaments of the auditory nerve in the labyrinth alone would scarcely be expected to increase the hearing power. On the other hand, it would be difficult to determine what degree of labyrinthine inflammation was necessary to impair the perceptive functions. Labyrinthine inflammation, viewed from a clinical point of view, is doubtlessly nearly always consecutive to middle ear disease, but whether existing independently or in conjunction with middle ear trouble, the transmission of sound would be more effectively performed by means of aërial conduction as regards intelligible perception. In middle ear disease, however, the tuning-fork would be better heard through the tissues inversely to an increasing defect in aërial transmission, but not necessarily better heard, however, on account of labyrinthine defects.

Even if the auditory filaments were alone affected, the tuning-fork would be best heard by aërial conduction, since the transmitting apparatus affords the better conduction, and at the same time interferes with osseous conduction. But recognizable cases of labyrinthine disease alone are rare, and it is difficult to establish the fact that no middle ear disease co-exists in any given instance.

From the foregoing we may, therefore, arrive at the following conclusions:

I. When the vibrating tuning-fork, placed on teeth or vertex is better heard through the tissues on one side, it simply indicates that the better ear excludes wholly or in part such (tissue) transmission, but it does not prove that the auditory nerve in either ear is affected.

(Of course, if the nerve of audition be gravely affected, sound will not be heard by any method of conduction.)

II. If the conductive mechanism is absent or greatly damaged in one ear, while the other remains normal, aërial transmission will be found to be more or less ineffectual in the diseased ear, while the tuning-fork allowed to vibrate as before will, therefore, be best heard in the diseased ear, and its vibrations will be almost entirely excluded from the healthy ear.

III. In deafness from labyrinthine disease, pure and simple, the middle ear being normal, the tuning-fork will be best heard, if heard in any degree, by aërial conduction, because bone conduction would be excluded.

(In those extreme cases where destructive disease of the nerve has taken place, impulses of sound may be appreciated irrespective of either the transmitting or labyrinthine structures; thus the deaf-mute is conscious of the sound of thunder, artillery, drums, stamping with the foot upon a floor, and the like.)

NOISES IN THE EAR.

Tinnitus Aurium. Persons frequently seek relief for the distress arising from these sensations solely, though considerable deafness may have long existed without inconvenience.

Noises in the ears and head are nearly always present in some degree in both acute and chronic aural disease, and ka nowledge of their significance is necessary in arriving at a correct diagnosis. It is well to remember that the imagination and descriptive power of each patient varies in regard to the character of the noise experienced. Neuropathic and mentally unsound persons often give very absurd and whimsical accounts of their sensations in this respect. Though these noises are altogether subjective, patients are apt to fancy that others can hear them.

The most common description of noises in the ear is that of tinkling or tingling, "a tremulous jarring in the ears like ringing metal, when struck," as the continuous vibrations of a bell.

They frequently remind the patient, however, of some familiar sound; thus the domestic fancies that they resemble the sound of frying food, boiling water, and the like; the rustic compares them

to the agitation of leaves in the forest by the wind, or the singing of insects, etc. Persons accustomed to the roar of the surf, or to water falls, or machinery, or music, have these sounds brought to mind. Sometimes a monotonous ringing or singing in the ear is experienced continuously. In chronic catarrh of the middle ear, these phenomena are very constant; the more sensitive or imaginative being greatly distressed by them, whilst insensitive and unimaginative persons often scarcely note their existence.

Noise in the ear, seldom absent in chronic middle ear affections, is subject to exacerbations from mental excitement, especially when this causes increased cardiac action; it may then be so excessive as to greatly increase deafness by interference. The despondency and alarm experienced by patients from this cause will be more fully considered further on.

Noise is scarcely ever absent in acute aural affections of any region of the ear, and not infrequently is so marked as to be referred to as pain. The writer recalls, among the descriptions of their sufferings given by patients, the significant statement of a woman, that she had a "roaring pain" in her ear, and of another, that she experienced a "noisy dizziness in the head." When pain and vertigo are associated together in aural troubles, as was evident in the above instances, the distress to the patient is sometimes most alarming.

The causes of noises in the ear are by no means always the same, though similar phenomena are doubtlessly due to similar causative influences. Perception of sound implies the previous existence of sound vibrations, and since the perceptive tract of the brain itself is, probably, not liable to thus propagate sound in its own tissues, we must look to the inner and middle ear for their origin, and especially to anomalies in the transmitting mechanism of the latter.

The physiological function (auditory) of the *portio mollis* of the seventh pair of cranial nerves would seem to consist in carrying impressions whose mode of motion is adapted to nerve transmission. Touch upon any surface of the body is thus transmitted by sensory nerves, and, whilst the auditory nerve is more highly specialized in respect to aërial touch upon the drum-head, it seems to be susceptible to other sensory impressions also to some extent, since vertigo or shock may ensue from syringing, probing, or wounding the ear.

There seem to be two principal sources of noise in the ear, namely: 1. From disturbance of tension of the transmitting mechanism of the ear, and 2. From disturbance of tension of the perceptive mechanism of the ear.

I. Noises due to disturbances of the drum may be of temporary

duration only, as from hyperæmia due to flushing, or congestion, the effects of head colds in which the drum cavity is involved, reflected dental or naso-pharyngeal irritation, etc., or otitis media from any cause. Recovery from these is often speedy and without leaving any permanent defect.

Where sensory affections of the drum have produced hypertrophic, atrophic, or sclerotic changes, the transmitting mechanism may become relaxed on the one hand, or ankylosed, especially the stapes, on the other hand. In otorrhœa, or in some subjects of chronic pulmonary or renal disease, where rapid and irreparable breaking down of tympanal tissue takes place, excessive disturbances in audition are experienced, and other sounds than buzzing or ringing take place, to which allusion will soon be made. In the sudden deafness due to syphilis [1] noises and vertigo are specially marked.

When changes in the structure of the drum take place from trophic or other pathological causes, resulting in loss of tension or in fixation of the ossicula, noises are more or less permanent.

Collections of fluids or other products of inflammation in the tympanum, interfere with the movements of the transmitting apparatus, and also alter the resonance of the drum cavity; the significance of these will be duly considered.

Contractions of the tensor tympani muscles are sometimes the cause of noise in the ears, as well as the impaction or occasional impingement of cerumen or foreign bodies on the drum-head.

II. The disturbance that sometimes occurs in comparatively healthy ears from the effects of alcoholic stimulants, quinine, anesthetics, tea, coffee, tobacco when smoked, mental emotion, strain of the respiratory and abdominal muscles in efforts at expulsion of the contents of those cavities, etc., whereby nervous tension is impaired, seems to give rise to nervous impulses which become audible. They are heard as gentle tingling or hissing sounds commonly known as tinnitus aurium. Such phenomena have been regarded as due to increased vascular activity, and, indeed, our present knowledge of nerve action is too limited to satisfactorily explain the modus operandi of transmitted nerve force (or whatever it may be called), and the views advanced must, of course, be regarded as suggestive only until verified by further observation.

In regard to the anomalies of hearing due to defects in the transmitting mechanism, it may be said, that the moment aërial sound

[1] Vide "The Sudden Deafness of Syphilis." Samuel Sexton: American Journal of the Med. Sciences, July, 1879.

transmission suffers impairment, hitherto unheard undulatory movements arising from the circulation of blood in the neighborhood of the ear, and other sounds, are taken cognizance of through intervening tissues, specially the osseous. The impracticability of tissue conduction ordinarily is due to the fact that in normal tension of the conductive mechanism of the middle ear other sounds than aërial are practically excluded. But besides the noises arising from vibrations occasioned by the movement of blood in the arterioles in the immediate neighborhood of the ear, other and louder sounds are also sometimes heard, arising from cardiac and respiratory movements, vocalization, the flow of blood through the carotid canal, the lateral sinuses, etc., and the acts of deglutition. The sounds of the heart seem to follow the column of blood up to the ear, giving rise to throbbing or pulsating sounds. In acute middle ear inflammation the sensation is sometimes described as that of the violent action of an engine's piston or of pumping machinery. The concussions of the carotid are probably more severe when fluid is present in the drum, their frequency being synchronous with the beating of the heart.

Another group of sounds proceed from the friction of the articular surfaces of the ossicles themselves, either during excursions of the membrana tympani, or when the patient moves the head suddenly, or stoops; they, of course, are not continuous. These sounds are described by patients as "ticking," "rubbing," "grating," etc., or like "something loose in the ear." In some instances the noises resemble the sound produced by jingling delicate pieces of metal together, in others, the tapping of wooden substances; the pitch varying in almost every case and in the different stages of the affection.

The drum-head also contributes peculiar noises of its own when its tension is lost and the humidity of the drum is either greater or less than normal. Thus, when agitated by sound vibrations or acts of swallowing, respiration, or eructations, the relaxed and dry membrane gives forth a rattling noise like the crumpling of parchment or paper, and when tenacious mucus, and the like, is present the ear seems to "open and close" under the conditions just described, with a feeling of separation between two sticky surfaces.

Whilst the phenomena of noises in the ear may occur in the course of most aural affections, in advanced life they are particularly distressing, since senile changes in the drum are liable to gradually render the transmitting mechanism defective even where chronic inflammation has not been marked. The distress of the menopause is greatly increased by the co-existence of aural disease attended with auditory acoustic anomalies, as is shown by the following case:

The patient was a lady, 51 years of age, who consulted the writer in 1877. There was a history of deafness and tinnitus of several years' duration, after which attacks of the character under consideration began to come on, with flushing about the face and head, with great nervousness and vertigo. The tinnitus experienced was most painful, she herself designated it as "frightful, like the rattle and crash of a train of freight cars" at one time, whilst at another it seemed "like the rumble caused in a room overhead by rolling barrels over the floor." Sometimes she heard "the rushing of water or the intense roar of steam escaping from the steamer's funnel," and other disagreeable sounds. Finally, after becoming exhausted by a severe attack, an interval of comparative repose ensued, during which she fancied that she heard the singing of a church choir in the left (worse) ear. This occurred in the retirement of her own room where quietness prevailed, and has since frequently recurred. When upon the street, in a railway train, or where there is much noise, she not only hears much better, but is quite free from the distressing acoustic phenomena above described.

AUTOPHONIA.

Syn. Pseudacousma or False Hearing. The tension of the transmitting mechanism of the middle ear, or the resonance of the drum become so changed in certain aural troubles that the patient fails to hear his own voice in the usual manner; it does not appear to issue forth from his mouth, and then come around and strike upon his ear-drums. It seems to fail of utterance in the usual manner, but passes directly up to the speaker's ear from within the head. Speech thus gains access to the nerve of hearing by traversing the tissues between the vocal organs and ears in a direct line, or along the aërial tract of the Eustachian tube when open. And, in fact, the sounds of the patient's own voice also pass into the ear to a greater or less extent in the usual manner, though seeming to reach it from within altogether, since the voice of others may be quite well heard in the affected ear. Sometimes both ears are affected in this manner, but if the disease is confined to one of them, he then receives normal sound impressions in the usual way in one ear, whilst the same impressions are perverted by the other ear, and are heard as *false* both as regards pitch and timbre. In a certain number of cases the resonance of the drum cavity, with or without unusual patulency of the Eustachian tube, is such that a distinct "echo" occurs after each word spoken.

Autophonia occurs during the progress of a large number of middle ear affections; also in diffuse and circumscribed inflammation of the external auditory canal, and from the presence of ceruminal collections or foreign bodies therein. The anomalies of

hearing due to intra-tympanal air-renewal include this phenomenon, and the impact of sound or of water syringed into the ear may cause it.

In both acute and chronic affections of the middle ear, though most frequently in the latter, the articular surfaces of the ossicula are liable to be disturbed, especially the malleo-incudal joint; and one result of this is loss of tension. Tension is also disturbed where manometric restoration of the drum-head exists.

In respect to the former, it is well known that the peculiar construction of the malleo-incudal joint permits of disarticulation in such a way that the transmitting mechanism fails to respond normally to sound-waves arriving through the meatus externus, while those propagated by phonation, respiration, circulation, etc., are now effective upon the base of the stapes, and *probably also upon the membrana tympani secundaria*. In both anomalies effective oscillation of the drum-head requires increased intensity of aërial impact, since it must be forced inward far enough to re-establish tension through coaptation of the articular surfaces in one instance, or by putting the relaxed membrane on the stretch in the other.

When sound passes from the vocal organs to the ear, *via* the Eustachian tube coincidentally with its passage through solids, there is much confusion from interference, and when the voice of others is heard at the same time, the discomfort is further increased.

The closure of the Eustachian tube in acute inflammation of the drum, with consequent retraction of the drum-head, may also give rise to autophonia.

It would seem that in certain derangements of the euphonious ear by disease, the back door of the organ is thrown wide open to the wild uproar of tuneless noises, and that beside the bewildering effect of the autophonous voice, cognizance is taken also of the sounds propagated by the busy circulatory movements occurring always, though unheard in the healthy state, in the blood-vessels which course near the ear. The din often experienced seems to be altogether out of proportion to the origin of the sounds, and, especially in nervous subjects, the vibrations caused by the larger vessels, and by the autophonous voice, often seem to possess the pitch of thunder or artillery detonations—the head and ear being fairly rent and split with the resounding clangor. The writer has even known persons to declare that the sensations experienced were to be compared to the rushing and rattling movements of a railway train traversing the head.

The apalling effect of these deafening and piercing reverberations

can be better understood when it is considered that the head in autophonia very often seems like an echoing cavern in which these violent sounds, consisting in part of slamming, cracking, snapping, knocking, clashing, rumbling, humming and hissing noises, suddenly manifest themselves. That the impact of these autophonous vibrations often gives rise to cerebral disturbances, though not always to the extent of producing unconsciousness, and leaves the patient in a prostrate condition, can be readily understood.

Next in importance to the changes in the ossicula as a causative abnormity is the movable drum-head which, indeed, is the essential agency in causing the interruptions that occur in pseudacousma; or so long as a certain tension in the ossicular chain remains, the drum-head may be greatly relaxed, suffer much loss of substance by perforative inflammation, or become thickened and loaded with opacities, without causing false hearing. Some authorities trace the origin of many of these phenomena to affections of the inner ear, but the writer does not believe that a decisive conclusion, in which all shall agree, will be reached until more time and attention shall have been devoted to the study of the physiology and pathology of this subject.

Absolute certainty in diagnosis is not possible until our knowledge of the physiological functions of the terminal filaments of the auditory nerve has a more substantial foundation than theory alone. Otologists have given no little attention to the subject, however, during the past fifteen or twenty years.

Patients who experience autophony are aware that the pitch of the voice has undergone a change; in certain cases it seems lower than natural, and sometimes it is described as hoarse; such patients, when singing or speaking, raise the voice above the natural pitch. On the other hand, the voice sounds unusually loud to some individuals, and, in order to avoid disturbing others, they speak in low, or even whispering tones. When autophony is intermittent, the patient will alternately raise and lower the voice during conversation.

The following case is of interest here:

The patient was a commercial traveller, 34 years of age. He was first seen by the writer in April, 1879, at which time he believed himself to have some throat trouble. A careful examination of the vocal organs had been made, but all assurances of their healthfulness failed to entirely convince him that the difficulty was elsewhere. An examination showed that there was chronic catarrhal inflammation of both ears, evidently of long standing. The voice, he stated, had

been autophonous for three years, and it sounded so disagreeably he was unable to sustain vocal efforts long at a time. In consequ of this disability he lost his situation, and, for a short time b consulting the author, his precarious livelihood depended on hi ertions as a canvasser. Whenever the autophony came on—it wa termittent—all business had to be put aside for a time, and attacks lasted for hours, when the mental depression was great. T attacks came on quite suddenly, were characterized by most dist ing roaring in the ears, which was increased by every attempt to the voice. The mental condition seemed to favor palpitation o heart, and, altogether, the attacks left him exhausted for a time incapacitated for work. The tinnitus aurium and autophony were cause of great deafness, but, when absent, the hearing was good. patient asserted that he had frequently thought that suicide woul preferable to the distress he had to endure. The writer's first e in this case was to convince the patient that the anomalies experie in no way prognosticated danger to life, and an absence of dread been followed by almost entire relief as regards the severe parox described.

These phenomena cannot be experienced by any persons wit distress, for even a simple cold in the head may give rise to hearing, not from physical disability as regards the throat, but the autophonous voice that so accompanies the "stuffiness" in ears then felt. This condition should not be confounded with simple nasal tone acquired by reason of a stoppage of the n passages from any cause, for in this state the patient's voice sou alike, both to himself and others.

False hearing and autophony may be experienced at any They usually announce themselves suddenly in the course of a aural affections, as has already been stated, and disappear as quic In chronic cases, however, their development is more gradual, they are then more persistent.

The transmission of sound, under certain circumstances, thro the tissues of the body to an ear affected by disease, is of frequ occurrence. Patients not infrequently complain of the unpleas sensation thus experienced by hearing their own footsteps on pavement, or the heavy rumbling sounds of the street.

THE EFFECTS OF FALSE HEARING (AUTOPHONI ON SINGERS, ACTORS, LECTURERS, AND MUSICIANS.

The consequences of false hearing are very serious to those w earn a livelihood by the use of the voice. It often happens, howev that, when incapacitated for their pursuits, attention is not direct

to the real source of trouble in the ear, but advice is sought for some fancied affection of the throat, which is supposed to modify the voice.

The consequences of autophonia in decided impairment of the ear structures are most appalling to musicians, since the mind can receive harmonious impressions no longer; singing or instrumental performances are not possible, but the mere perception of music gives rise to disagreeable emotions. When the subject of false hearing performs on certain musical instruments, especially upon the violin or the cornet—instruments held in contact with the face or lips when played upon—he finds that sonorous vibrations appear to fail to issue forth from the instrument; that, like autophonous voice, they are only recognized by him as resounding within the head.

The following cases from the author's records illustrate what has been above stated.

The vocalists are, for convenience, arranged in one group, the performers on musical instruments in another.

CLASS I.—VOCALISTS.

CASE 1.—A singer, 52 years of age, suffering from an acute purulent inflammation of the left middle ear, which had been greatly aggravated by the ill-advised use of an irritating lotion. There was deafness to ordinary sounds, and in speaking he experienced autophony; when he attempted to sing in the church choir to which he belonged, he was unable to strike the correct pitch, his voice sounding unnatural to him; when he sang, his notes were a "confused jumble," as he himself expressed it. This case proved to be a very grave one, and the permanent injury to the conductive mechanism prevented an entire cure as regards the autophony. After his entire recovery from all inflammation, which took place in about a month, the autophony yet remained in some degree; he could, however, remove the symptoms by pulling the tragus firmly outward and downward.

CASE 2.—Patient, a lady, 34 years of age, came to the writer's office in September, 1880, with chronic catarrhal inflammation of both middle ears. The disease was of several years' standing, and since it was first noticed until the present time there has been a gradual increase in the deafness, and she can now only hear loud conversation. For two years past she has been unable to sing without hearing the sound of her voice most unpleasantly in her ears; however great her efforts, the notes appear to die away without utterance. Her voice is a very good one, but she sings without any confidence in her own power. She hears conversation best when in a rumbling conveyance, or on a noisy street.

CASE 3.—A gentleman, 46 years of age, while suffering from an itching of the external auditory meatus, was advised to drop into

manifested itself when held against the left cheek while played upon, for when it was held away from the face its tones were heard in the usual way. Normal hearing returned on his recovery from the aural disease, which was in about three months from the beginning of the attack.

CASE 6.—This patient performs on a cornet in a small orchestra; he is 35 years old. He came to the writer in January, 1879, while suffering with an acute purulent inflammation of the left middle ear; in this ear he was deaf to ordinary voice. When he plays on the cornet he fancies that no sound issues forth from the instrument, but that from his lips the vibrations go back to the left ear, from which they resound again most unpleasantly. When attempting to play upon the cornet with the orchestra, it seems to himself to be pitched a quarter of a note higher than the other instruments, and when he lowers the pitch to that of the orchestra, he is told that he plays too low. After several futile attempts to play in tune, he was obliged to throw up his engagement. A violin played upon, while resting against his left cheek, sounds more loudly than if heard in the natural manner. The effect of orchestral music on the affected ear was peculiar—it seemed to be "damped." The cornet's tones, for example, sounded like that instrument when the "mute" is used. The music, however, was distinguished, unless low tones, which were first imparted to the floor before reaching his ear through the body, had the effect to confuse his perception in some degree. By placing his hands on a piano, while the cords were in a state of vibration, the sound was carried to the affected ear through the tissues of the body. This patient's voice was autophonous. His recovery from the severe aural affection was slow; a cure, however, was effected in three or four months, and it was then found that he had not been permanently incapacitated, inasmuch as he resumed his former place in the orchestra.

CASE 7.—Patient is likewise a cornet player. His age is 53 years. The author first saw him in September, 1880, three weeks after he had contracted a severe cold from exposure going home one stormy night from a performance. A few days after the exposure there was deafness in the left ear, and he could not hear conversation spoken in a low tone. Examination showed an acute catarrhal inflammation of the middle ear. It was found that he was deaf to the notes of the highest organ-pipe. When he plays upon the cornet, the whole volume of sound seems to himself to pass backward and escape out of his head through the left ear. He has autophonous voice.

The attack in this instance was a mild one, and the patient resumed his place in the orchestra in about a week after he first came under observation.

He could play upon the violin, and from an experiment made during the aural attack it was found that this instrument was heard false, the phenomena experienced being the same as were reported by the previous patient under very similar conditions.

CASE 8.—The patient, a teacher of music, aged 41 years, was sent

by a medical friend in October, 1879. His deafness was very great; he hears words only when shouted directly into his ears. For the past eleven years he has suffered greatly from both autophony and tinnitus aurium. The cause of these most unpleasant symptoms is chronic catarrhal inflammation of both the middle ears. He has become exceedingly nervous and irascible, and his conduct makes his family as wretched as himself. Thoughts of putting an end to his life are constantly in his mind. He states that since his sufferings began he has been under the treatment of nearly every prominent aurist in this country and in Germany, besides many general practitioners, but without benefit from any; indeed, it is to be feared that his sufferings have been increased by the frequent inflations to which the drums have been subjected by the Politzer method. Before he had any serious disease of the ears, he played upon several musical instruments, but their sounds to him are now tormenting. His wife states that he is most of the time "wild with nervousness," that the noises in the head, when the voice is most autophonous, convince him that he must be possessed of some serious ailment. Frequently he refers to his throat as the seat of some disease. For several years past he has devoted whatever strength and means remain subject to his control, to travelling about in search of relief. This patient was benefited by the use of cotton-wool pellets, adjusted to the relaxed conductive mechanism, but he was unable to keep them in place very long without causing irritation of the drum-head.

CASE 9.—This girl is now receiving musical instruction on the piano. She is 13 years old, and has a talent for music. She was brought to the writer in November, 1878, while suffering with acute catarrhal inflammation of both middle ears, caused in part by reflected dental irritation. The right ear was most affected, but the voice was autophonous in both. With the autophonous voice in the right ear, she describes the sound of the voice as remaining there a perceptible period of time, and having a timbre resembling a vibrating piano cord. The piano, heard at a distance, sounds damped, but is not unmusical. All of her efforts to perform on the instrument are unsatisfactory, for the sounds reaching the ear by tissue-conduction—through the body—are heard false, and create an unpleasant and discordant jangle. A good recovery was made in about two months, when she resumed her musical instruction. The hearing, which of course had been imperfect, was entirely restored.

CASE 10.—The patient is an organ-tuner, aged 23 years. His hearing was always good until three weeks before coming under observation, in September, 1879. He now had an acute purulent inflammation of the right middle ear. In this ear he cannot hear ordinary conversation. In the other ear the hearing is good. There is autophony and tinnitus in the affected ear. He is unable to tune an organ, for when he blows the tuning-pipe, its sounds seem to be within the head; and furthermore, the beats above upper F are indistinguishable, unless the ear is close to the pipe. Normal hearing was restored after five weeks' treatment.

It will thus be seen that in false hearing the sounds of the voice or the cornet are transmitted in a more or less direct course through the intervening tissues from the mouth to the ear, to be heard, so to speak, from within the head. Undulations of sound in speaking, singing, or playing upon the cornet are, of course, always transmitted to the ears through the intervening tissues, as well as by the air, but in the normal state of the transmitting mechanism the former are simultaneous or excluded; otherwise, there would be confusion from interference. Even if these media transmitted sound from the mouth to the ears with equal velocity, confusion would still ensue, for the ear would be unable to harmonize the undulations received in both a normal and abnormal manner at the same time—the one through the air, the other through the tissues. A patient who experiences autophony finds it a difficult matter to locate the precise source of his own voice, as it approaches the ear from an unfamiliar source; this experience, moreover, seems to vary in different patients, some locating it in the ear itself, others in various regions of the head. A lady, for example, who suffered with autophony, informed the writer that her voice seemed to go out of the back of her head, and she fancied it was heard by those standing behind her only. To some the vocal intonation is so unfamiliar that it is difficult for them to believe that the voice is not spoken by another, and that the speaker is at a distance or in a different apartment. In certain instances the patients describe the voice as remaining in the ear a perceptible period of time or as echoing in the head; these are most confusing experiences, inasmuch as they give rise to the sensation of the head being "empty" or "hollow." Musical people, when experiencing this feature of pseudacousma, either in singing or playing upon certain instruments, likewise find the tones produced lingering in the ear, and seeming to have a different pitch than at their inception.

A very slight cause, as a cold in the head, may so disarrange the conductive mechanism that a singer's voice becomes false to an incapacitating degree, and while the pseudacousma exists he cannot pitch his voice to the same tone with other singers or with an orchestra, because he hears his own voice in a false tone as compared to the accompanying tones which he hears with greater or less distinctness. A similar difficulty in keeping in tune is experienced by performers on certain musical instruments. When the conductive mechanism is subject to frequent alterations of tension in these cases, as when the membrana tympani is greatly relaxed, the frequent changes from true to false hearing are exceedingly distressing, for at one moment sounds strike on the ear with a pleasant effect, and at the next they

seem muffled; at the same time certain notes, especially the lower ones, produce a very unpleasant jar upon the ear.

It is well known that some large buildings, in the construction of which wood largely enters, have a certain resonant quality, and the timber at times takes up musical notes; indeed, every church building, it is said, responds to some note of the organ, when the whole building will be shaken. The vibrations of the drum-head itself, when responding to the notes of a thirty-two-foot organ-pipe, may be *felt* as a succession of shocks rather than heard. The lower tones, bass drums and brass instruments, and the rumble of heavy trucks in motion, are likewise sometimes distressing to even the normal ear.

The *diagnosis* of autophonia is not always easily made, as the phenomena vary in almost every case, and the patient's description is liable to mislead. Owing to the patient's fancy respecting his changed vocalization, and to the sympathetic cough that so often accompanies aural affections, the patient's throat is likely to receive an undue share of attention; this fact should not be overlooked in any case, but in singers it is important, for obvious reasons, to avoid any influence of this kind in treatment. One important fact should always be kept in mind in cases of false hearing, namely, that the phenomena pertain almost exclusively to sounds reaching the patient's ear from within. Of course, if the patient is so deaf that his own voice does not affect his drum-heads from without, he constantly hears false in a certain sense, but we are here more particularly concerned with that state where the false hearing is of a variable character. Such intermittent pseudacousma is common during acute inflammation of the middle ear, especially when the case is recovering, and also in certain chronic catarrhal inflammations of the same region. In these cases the patient, while singing, reading aloud, speaking, or playing certain instruments, may suddenly hear the sounds produced resounding in the head, while he fancies their tone must be quite unnatural to others. These unpleasant symptoms usually disappear, for a time, as suddenly as they came, and the increased deafness for external sounds, which always exists while the pseudacousma lasts, also disappears. The interruptions vary in their duration from a few seconds to days or even months.

The *prognosis* of pseudacousma in acute affections of the middle ear is usually favorable, as normal hearing is re-established in a very considerable number of cases, and false hearing disappears in nearly all of them. When, however, the anomaly occurs in the course of chronic catarrhal inflammation of the middle ear, it is a very persistent symptom. In the cases where it arises from dislodged collections

of cerumen that impinge on the drum-head, or from foreign bodies, the removal of these is usually sufficient to relieve the patient. With the cure of furuncles or of diffuse inflammation in the external auditory meatus, the result is likewise favorable.

As regards *treatment*, we can scarcely ever confine ourselves to the treatment of these symptoms alone, and after all pseudacousma is only a symptom that may accompany many aural diseases ; any attempt in this direction would, therefore, carry the writer beyond the scope of this chapter.

The successful treatment of any aural disease, however simple its nature may be, often depends on the recognition of the value of the symptoms here discussed, and we should not fail to keep them in mind when considering the management of our cases. The absence or presence of the acoustic symptoms, pseudacousma and tinnitus aurium, is a valuable guide in treatment, although our remedies should meet the physical conditions rather than the acoustic, knowing as we do that hearing will generally return when the former assume their wonted sway.

CERTAIN OTHER ANOMALIES OF AUDITION.

There are some anomalies of hearing that, to a thorough knowledge of this subject, should be alluded to, although not classified with false hearing; the following are examples : A gentleman contracted from sea-bathing an otitis media serosa of the right side. The external auditory canals were large, and in diving, water was freely admitted to the drum-heads, the right one, on examination, being found moderately hyperæmic. The tympanic cavity contained a considerable quantity of serous fluid, which could be observed to change its position whenever the patient moved his head. When the drum was inflated with air by Valsalva's method, the fluid was thrown into bubbles which lined the whole inner surface of the membrane. As he suffered but little pain or deafness from this attack, he did not apply for treatment until the fifth day after getting the sea-water in his ears; it was at this date that the above observations were made. His voice was now autophonous, and his footsteps jarred very plainly in the right ear. He could hear a low tone of voice in both ears, but the highest pipe of the organ could not be heard in the affected ear. This gentleman, when a youth, sometimes followed the hounds. It was then well known to all of the hunt that he could hear the dogs better than others; in fact, even after all the rest had ceased to hear them, if the party kept quiet he could hear their deep notes and also

indicate the direction from whence they came. He related to the writer another interesting experience illustrating his wonderful capacity to distinguish low tones. When boating in the Great South Bay, L. I., a few years ago with some friends, he heard the low peals of thunder that accompanied the sheet lightning then attracting their attention—a phenomenon which was inaudible to all of the party but himself; his companions were aware of the flashing only. His recovery from the otitis media serosa was rapid and complete.

Another case of much interest came to the writer's notice.

Capt. Henry Erben, U. S. N., consulted him for a slight discomfort in the right ear, which was found to be due to the presence of some stiff hairs that had fallen into the canal after having been clipped off by the barber. In conversing on the subject of his hearing, Capt. Erben informed the writer that his perception of distant sounds had always been remarkably acute, but that in a large hall or theatre, words spoken were not distinctly heard; sometimes the words seemed to run together in a confusing fashion, and a word would be frequently lost altogether.

Referring to the distinctness with which he heard distant sounds, as of the voice or great guns, in a communication dated January 13th, 1888, he said: "In 1862, when I was on the *Huntsville* off Mobile, on blockade duty, this occurred: We had just dined below and were going on deck, some eight officers of us, when on reaching the upper deck I heard the boom of a great gun to the westward. The sound was distant to me, yet not another officer heard it. Again and again came the sound to my ears, and so certain was I of the distant firing, that the captain was induced to order one of the small vessels of the squadron to go in search. Finally, after a long while, others on the *Huntsville* made out the report of guns and we then also went in chase. It resulted in the capture of the *Magnolia*, a blockade runner with cotton, which had run out of the Mississippi River, and had been chased and fired at by the U. S. S. *Brooklyn*. Upon inquiry, it was found that no one on the other blockading vessels had heard the *Brooklyn's* guns until she was in sight from aloft. In the harbor of Rio de Janeiro, Brazil, upon one occasion I very plainly heard the breathing and struggling in the water of a man, to which I called the attention of those on deck of the *Huron*, my vessel; but no one heard the sounds. A boat was lowered, however, and directed to pull in the direction from which I heard the sounds come, with the result of picking up a sailor who had tried to swim ashore from one of the men-of-war, and was nearly exhausted when found. Another instance, out of many that I might mention, and I

leave you to draw your own conclusions as to the acuteness of my ears; and I assure you they have done good service in the direction indicated, while not entirely useless in taking cognizance of things near at hand, as sailors' yarns for example.

"Off the Texan coast, of a dark night, I heard the words of command given in a low gruff tone of voice: 'Port your helm! Ahead full speed!' come from astern my vessel. None of the others on deck heard these words; but in a few moments a vessel ran past us towards Galveston, thus receiving our fire as she passed. The incident had passed out of mind, until last summer, when I met a person who had been aboard of this blockade runner at the time; they were waiting until nearer midnight before attempting to run in, but seeing the light from a cigar on my vessel's deck, they determined to dash past us. The words of command had been given in an undertone, and it was a surprise to this gentleman that they had been heard so far.

"During gales at sea I never find it difficult to make out what men may say from aloft; in fact, this peculiarity has long been recognized by myself and others."

The writer was surprised to find, on testing Capt. Erben's hearing for high notes with König's series of rods, that he was unable to hear any vibrating over 20,000 per second. The external auditory canals and drum-heads were rather larger than usual.

A case reported by Dr. Charles H. Burnett is also of interest.[1] The patient was a young lady, of musical acquirements, who had good hearing except for low tones, like the bass notes of an organ, or thunder; as regards the latter "she first became aware of her deficiency while walking in the fields with her father, for the latter could distinctly hear the thunder of an approaching storm," while "she could hear nothing of the kind." Dr. Burnett does not report any peculiarity in the auditory apparatus in this interesting case. In the writer's own case above noted, the drum-membranes were among the largest he has ever seen, and slight inflation by Valsalva's method caused bulging of the drum-membrane on both sides of the malleus handle. The flapping membrana tympani seem not to affect the hearing for ordinary sounds, the tension of the chain of ossicles probably remaining intact.

Attention has been called by writers to the fact that, in certain cases where deafness exists, the patients could best hear the notes of the middle register of the piano. The number of observations

[1] Trans. of the American Otological Society, Vol. I., page 106.

having been too few to throw much light on the subject, the author determined to institute some experiments on a considerable number of patients at the same time, and as the piano was not considered the best instrument for the purpose, he requested Prof. Mayer, of the Stevens Institute of Technology, Hoboken, to conduct some experiments with him on a large church organ. Two of the patients whose hearing was tested on that occasion are of interest here; they were both of them women of about forty-five years of age, extremely deaf to conversation, from the results of chronic catarrhal inflammation of the middle ear. Neither of these patients could distinguish the higher notes, but when the *middle register* was reached they could plainly hear the notes sent forth by the organ. Below the middle register these patients heard no sound again until the lower notes were sounded; these were heard by both of them. The experiences of others present on this occasion seemed to confirm the observation respecting the capability of some individuals to hear the middle register best; one of them, a gentleman of musical education, although hearing all the notes in some degree, found that those of the middle register were heard most distinctly. The following case is another example: A piano-tuner, fifty years of age, who had been thus employed for twenty-five years, gradually became quite deaf; it was finally ascertained that in tuning a piano, after passing above the middle, he began to sharpen up to the end of the scale—in the three octaves he sharpened a fifth. This, of course, did not fail to dissatisfy the customers of the establishment that employed him, and he had to give up his occupation.

It should be stated that musicians with advancing deafness, after a while find that slight differences in the loudness of tones near the middle of the musical scale are not easily recognized.

Facts like these seem to confirm the physiological theory used in explanation of these anomalies, namely, that in such cases there must be some pathological change in the cochlea. Inquiries of practical musicians, however, elicit the statement that the cornet or reed stop of the organ is the clearest and most natural in the scale, and, therefore, most easily heard. On the piano, middle C is the equivalent of this, which accounts for its being heard better in certain cases.

DYSACOUSMA.

Painful hearing or *hyperæsthesia acoustica*, as it is sometimes called, is due to cerebral exhaustion, hyperæmia, or inflammation of the brain, whereby the organ becomes sensitive to impressions of

sound, as some regions, when inflamed, are painful to touch. Impressions of sound upon the nervous centre when in a state of excitability, as in persons suffering from nervous exhaustion, or in lepto- or pachymengitis, may be excruciating in the extreme.

The employment of the term "hyperæsthesia acoustica" in this connection is liable to lead to confusion, inasmuch as it implies that acuity of the auditory function of the nerve of hearing may be increased by irritation or inflammatory action. The writer cannot admit that the auditory function of this nerve can be increased beyond the normal state, although it is plain that pathological changes may impair its action. There seems to be no good reason why sensory impulses, however, may not be transmitted along its tract through fibres of the *portio dura*. The writer has witnessed central disturbance when the chorda tympani or other nervous filaments distributed to the external or middle ear have been irritated. Physiologists have not admitted that the auditory nerve has the dual function of transmitting sensory as well as sound impressions, and some writers have endeavored to overcome the difficulty by supposing the existence of separate nerve fibres accompanying the auditory nerve from the ear to the brain. We must not overlook the fact, however, that the situation of the auditory nerve precludes its assuming sensory functions ordinarily.

The following is a case in point:

Patient, a female, aged 33 years, married and has borne several children. Her father, mother, a brother, and a sister died of phthisis pulmonum. For the past year she has had much domestic trouble. She has had a purulent discharge from the right ear since childhood. All her upper teeth, excepting the first right bicuspid, a carious fang of which now remains, are gone. This fang is the cause of an alveolar abscess which had existed for some time. She has worn a full upper vulcanite plate of false teeth for several years, and its pressure on the fang mentioned has of late caused sufficient reflex irritation in the right ear to kindle an extensive acute inflammation of the connective tissue in that region, accompanied by severe neuralgic pains extending deeply into the temporal region. Pressure on the fang causes pain in the ear. Only a portion of the membrana tympani now remains, and there is some pus in the drum. The present attack began on November 13th, 1880, the pains being so great that the patient could not sleep or rest during the two days preceding the author's examination, made November 15th. On discovery of the alveolar abscess, the patient at once became aware that the principal seat of the pains was in the right upper jaw; but the pains in the head increased rapidly and on November 16th she began to experience vertigo and nausea to a distressing extent, and staggered greatly when endeavoring to walk. The patient now says that

sounds affect her very much; the rattling of silver or plates on a marble-top table, or the heavy rumbling noises heard when she is on the street, give her intense pains in the forehead, and make her tired. It was found on instituting inquiries that the sensitiveness to noises heard only occurs when the left or normal ear is open; when the loudest sounds of the voice are conveyed to the affected ear through a tube, she hears them imperfectly, but they do not give rise to pain. The clashing of steel is not painful so long as the sound ear remains closed, but the moment these noises are admitted through the latter, they give rise to severe pains in the forehead. Such sounds are, however, it should be said, heard normally. She is much exhausted by these experiments and says she feels very tired in the head. The patient could, to some extent, feel the impressions of sound when both ears are closed; they seemed to "strike the brain," as she herself expressed it, the sensitive spot being in the forehead.

Patient was physically well nourished, although she had been ill for a long time.

It would thus seem that the sensitiveness to sound in cases like the above, where irritation of the brain and its meninges certainly existed, is located in the brain, not in the ear.

In dysacousma, the ears, however, may be unaffected or even closed so as to exclude sound, and yet the impact of certain noises may produce painful impressions upon the brain, as though it had been "struck by a blow." The brain in some totally deaf persons is painfully affected by certain sounds, as of thunder or the low tones of an organ-pipe, whilst others cannot endure whispered sounds made directly into the ear; the cause of which would seem to be that the perceptive centre of the deaf is unaccustomed to any invasion of sound.

Sounds of low pitch undergo a modification in certain cases of acute inflammation of the middle ear; thus the low, heavy undulations of street trucks, elevated railroad carriages, and the like are heard as high in pitch, sometimes like a whistle. This condition is entirely distinct from that giving rise to *painful* perceptions of sound; it is due to disturbance of equilibrium in the transmitting mechanism, whereby its tension is probably increased, since it occurs in the course of acute inflammation of the middle ear and in the profound deafness due to syphilis. Of course, the impact of sounds of low pitch, when heard as high, may give rise to painful sensations in nervous persons.

Of interest in explaining anomalous action of the transmitting mechanism is the behavior of the telephonic diaphragm. On calling the attention of Prof. Graham Bell to this subject, he referred to the experiments made under his own direction by Mr. Thomas A. Watson, of Weymouth, Mass., in 1882. Mr. Watson, in a letter dated October

4th, 1884, informs the writer that sound from a bent or dented telephone diaphragm is diminished in volume, seemingly in proportion to the extent of the injury, and is often accompanied by a ringing overtone. A striking illustration of this was afforded by an experiment. A thin iron diaphragm, much damaged by inverting its edge all around, was pressed into a solid metal ring, so that its surface took the form of a shallow cup. The effect was always to render the sound *very* feeble, without giving any overtone. When a hole of one-third to one-eighth inch in diameter was made through a telephone diaphragm, sound was unaffected or become even a little clearer. "The vibrations of a telephone diaphragm are always accompanied by an overtone which varies with its thickness, becoming lower as this is diminished."

Straining a membranous diaphragm similar to the drum-head raises the pitch of the overtone. It was found that sound diminished in volume (amplitude) very rapidly, as the magnet was withdrawn from the diaphragm, though its quality (pitch) remained unchanged. The effect of a large cavity between the diaphragm and the inner surface of the plate, forming the mouth piece, is to add to the sound a strong overtone, due to the excessive reinforcement of a particular pitch of this resonating cavity.

Sound thus undergoes modification during its transmission through a defective telephone, and from the similarity of this instrument to the ear, we should expect that like changes would occur on its transmission through a defective ear-drum. Clinical observation shows this to be the case where mucus or other fluid accumulates in the drum during inflammation, or when the drum-head is swollen or thickened by means of a covering of exfoliative dermic tissue; or where its tension is disturbed from any cause, such as manometric cicatrices or opacities, ankylosis of the ossicles to each other or to the walls of the drum, and the relaxation or separation of their attachments, etc. Whilst, on the one hand, resonance of the drum may be altered by distention of fluids, and possibly by air or gases, it may be due, on the other hand, to the absence of the normal humidity of the drum, or retraction of the drum-head from closure of the Eustachian tube.

SOME OF THE RELATIONS OF CERTAIN AURAL PHENOMENA, HALLUCINATIONS, ETC., TO INSANITY AND BRAIN AFFECTIONS.

It is well known that certain individuals are unpleasantly affected by hearing slight sounds, as the crumpling of paper, the ticking of a clock, and the like, and that they are annoyed or startled by noises that strike upon the ear unexpectedly. Such persons are often greatly affected by disturbances of audition to which others attach but little importance. These people we designate by the familiar term of "nervous," and in this age of mental strain and over-excitement they compose a large class. The special sense of hearing may, therefore, afford the first intimation by which we may obtain a knowledge of the existence of nervous diseases, and the study of their relations to the brain is, therefore, one of great importance.

The writer desires to draw attention to some of the observations he has made in cases where the aural symptoms seemed to exert an influence in exciting nervous phenomena; where, for example, noises in the head have created so much distress that actual insanity has seemed to threaten, or where, in other instances, inflammation of the brain or its meninges has occurred, along with the intense neuralgia associated with these diseases. Where, therefore, a predisposition to alienation exists, or where this state has become established, the influence that aural affection would exert upon the diagnosis, prognosis, and treatment should not be overlooked.

From the cases given in connection with this subject, it will be seen that, what are called subjective noises, exert, under certain conditions, a not unimportant influence on the mind. It should be kept in view, however, that the noises called subjective have an actual existence and always depend on physical causes. That the over-excited brain or the superstitious mind may experience a psychical introversion, as regards the perception of these sounds, and thus mould them to suit the morbid fancies of the mind, in a given case, can well deserve belief. The insane know that they hear certain noises which others do not hear, and efforts to dissuade them from this belief may be, under some circumstances, unwise. It is a long time since the insane were observed to stuff wool and the like into their ears, but it is believed that the observation has never led to a thorough study of the subject. It is not uncommon to find the ears of the sane obstructed by pellets of cotton wool, inserted to exclude the "noises in the ears." These foreign matters, when left in the ears, become

frequently enveloped in cerumen and go on increasing in size from year to year. When pressure is exerted on the membrana tympani by such collections, the tinnitus aurium is much increased, and very frequently autophony manifests itself. Sometimes deafness is thus induced, which, of course, adds very much to the despondency of the patient, and increases his distrust of others. Patients who experience false hearing or autophony, and have at the same time distressing noises in the ears and head, are, even when otherwise healthy, under a great mental strain, and are frequently found struggling with all their strength against their misfortunes. Old persons often give way entirely to these depressing influences, living in a state of constant alarm; their condition is not understood by others, nor can they always explain their own sensations.

The character of these sounds in the ears has been described in another place, and will not be enumerated here. There is scarcely a sound in natural or industrial life that some patient or another cannot find its resemblance in the noises sometimes heard by them in the head.

These sounds are sometimes thought to indicate the presence of tumors in the ears, and the brain itself is often suspected of being the seat of a tumor. In many of these cases, an increase of excitement increases all the symptoms, especially those depending on the sounds of the blood in its circulation. It is stated, the writer believes, that insanity is not a disease of youth; it is also true that the more distressing aural diseases are mostly to be found after middle life, for it is at that period that we find the drum-head relaxed and the normal tension of the ossicles disturbed—conditions less remediable than the more acute affections of youth. It is then that the most bewildering phenomenon of autophony is frequently experienced; and one may add here, that but few sufferers are capable of describing this condition. These acoustic phenomena become more observable at night when quiet prevails; then every sound within the body, including the voice, sounds of the heart, and respiratory movements are heard with appalling distinctness. Slight movements in the conductive mechanism of the middle ear, such as occur from breathing, swallowing, etc., are liable to cause a sudden variation in these phenomena. One moment, the patient, in speaking or reading aloud, hears his own voice in the normal manner; the next moment, he only hears the altered voice within his head. The effect of these experiences on certain minds can be well understood. In this connection, it should be, furthermore, mentioned that persons are liable to be very much disturbed, when affected with the anomalies under consideration, by lying on the ear

when in bed. Trobbings are then more often experienced, and
times even the crushing down of the pillow contributes to the s
heard. From what has been said it will, therefore, be seen that
tions of the ear may give rise to nervous diseases, and when a p
posing cause exists, insanity itself may be induced. Mental d
sion they always occasion in the aged, and but few sufferers
despondency and distrust of their fellows.

The following cases are illustrative:

CASE 1.—Mrs. A. M., aged 25, consulted the writer in Nove
1880, on account of deafness. She was confined five years ago,
which time her health has not been as good as it was previ
She has noticed that she was becoming deaf for the past two
The tonsils are ragged, she has naso-pharyngeal catarrh, and h
perienced a great amount of dental irritation, especially durin
winter of 1878–9. The upper wisdom teeth were extracted in
The gum about the right inferior wisdom tooth has for two year
the seat of alveolar abscesses. The patient has even at times
obliged to keep her bed on this account.

There has been tinnitus aurium in the right ear for some time
and she hears occasionally her own voice autophonously—as sh
self describes it, her head "seems hollow," and she then
"dumb." This experience was associated by the patient with
of memory, and for a while she restrained herself from spea
When she is excited the ringing in her ears is much increased
she sometimes hears the tinkling of bells.

She hears the voice only when shouted in the right ear. I
left ear she hears no words spoken below the ordinary tone.

This patient has experienced a great deal of domestic tro
which, together with the facial neuralgia resulting from the dis
condition of the teeth, the tinnitus aurium, and the autoph
finally excited an attack of dementia. The neurologist to whom
patient was taken for treatment informed the writer that her at
were simply rage, that she had always been on the verge of insa
and is likely to become hopelessly insane.

Whatever the diagnosis or prognosis of this case may be, its hi
certainly shows the importance of early attention being given t
aural symptoms in all such cases. The author is inclined to be
that skilful treatment of the teeth in this case would have done s
thing towards preventing the progress of the deafness. It cert
would have cured the neuralgia which caused so much irritation
the head. The tinnitus and autophony alone were sufficie
greatly disturb the mind.

[This patient gradually improved, and gave no evidence of
mental disturbance until the summer of 1887, when a disposition

shown on one occasion to give way to rage on account of domestic difficulties.]

CASE 2.—Male, aged 59 years, came under observation in September, 1878; a tailor by occupation, thin, and with sallow complexion. He had in his childhood disease of the knee-joint, and since then has been lame. Twenty-five years ago he had pains in the right ear, followed by more or less discharge, and great deafness. He has now very severe pains in the region of the right ear, extending over the whole temporal space, and which prevents sleep at night. His family gave the information that his suffering is so great at times that he often expresses the intention of committing suicide. Three years ago he had an attack of vertigo, also a similar one a year ago. During these attacks, he experienced much pain, and staggered like a drunken man, sometimes falling down. His teeth have long been the seat of alveolar abscesses, from which there has been swelling about the right side of the face, the pains often extending from the teeth to the ears. The present condition of his teeth is a wretched one, the few remaining ones being denuded and loose. The right ear is found to be occupied by a large polypoid growth, springing from the lower wall of the canal. A discharge also exists. When the polypus was removed, it was found that a large, irregular growth, large and fleshy-looking, closed the canal just without the tympanum. Attempts to remove this with the snare were unsuccessful, and the patient declined to have it removed by the drill; also to have his teeth attended to. There was no evidence of the existence of mastoid disease.

He was not seen again until July, 1879, when it was learned that after the removal of the polypus, his condition had very much improved, with the exception of the deafness, now very great. He can only hear words shouted into the right ear. Patient suffered much from pains and the acoustic phenomena, autophony, and tinnitus. Soon after his last visit the discharge from the right ear ceased, but the pains and tinnitus continued, and the left ear also became painful. He died in July, 1880. Two months before his death he grew very deaf in the left ear. The pains and tinnitus in both ears became so unbearable that he tried to hang himself to escape from the terrible suffering. The family did not consider him to be insane, but concluded to send him to the New York City Insane Asylum, where he was admitted in February, 1880.

CASE 3.—Female patient, aged 39 years, married; no children. There is no history of miscarriages. She has always suffered from "colds" and toothaches. Has been addicted to the use of alcohol for many years. No previous aural trouble, excepting a slight attack of earache in the left ear three years ago. Tinnitus like "buzzing" began in the left ear about a year ago, but was unaccompanied by any deafness. Patient states that her "head began to feel badly" some time ago, and her eyes troubled her. About ten weeks since, she says, she suddenly heard the voice of deceased persons speaking to her in her left ear. These voices were both male and female. Since then

the same thing occurs daily, the voices using often profane obscene language, and calling her bad names. She hears also m singing, etc. She is annoyed by tinnitus aurium and autophc voice. Patient is fully persuaded that the voices she hears pr from some individual, and not from her own ears. The languag become much more abusive of late, she says, and within the two weeks the hearing in the left ear has diminished very consi bly. In consequence of these subjective symptoms, patient ha her appetite, become emaciated, and mentally much depressed. sits for long periods staring vacantly before her. Her eyesig very poor. She has also vomiting in the morning. Her right ear not trouble her at all.

Examination. Left membrana tympani is dull-looking and op especially in the posterior inferior segment, and retracted. The process is prominent. The membrana flaccida is hyperæmic.

The right membrana tympani is somewhat retracted, but of lustre. Hears low, ordinary voice at several feet in both ears.

Eyes. On examining the fundus of the right eye, the vessel seen to be fuller than normal; the inner end of the disc is indis and blurred. In the fundus of the left eye, nothing abnormal, appearances.

The pharynx is congested, and there are several carious teeth i jaws.

CASE 4.—Male patient, aged 40 years, came to the New York and Ear Infirmary in November, 1880. He was a laborer, empl by a horse-car company as a driver. He has a dark visage, an eyes, in looking at one, suggest that he is distrustful and has a bility for irresponsible acts. He stated that one year ago he h severe attack of delirium tremens, which kept him confined in a pital for two months. For some time past, however, he has been perate. He is forgetful and nervous, gets easily excited about tr affairs.

An examination of the oral and naso-pharyngeal cavities sh the existence of very carious teeth and a general catarrhal cond of these parts. The drum-heads were both hyperæmic in the ne borhood of the anterior superior quadrant. They were mottle appearance, and exhibited evidences of trophic changes. The dition of the left ear was the most marked.

His hearing is good; he can distinguish low conversation in ears. In his left ear he experiences a constant "whiz."

For the past six months, he fancies that some one is talking to every night, the voice seeming to enter the left ear. He is awake a long time by the voice, which repeats over and over ag "Get up! won't let you sleep!" or at other times: "You dam scoundrel," "I'll kill you!" etc. Such expressions are rarely e rienced in the daytime unless when it is very quiet. While writer was examining the patient, the latter told him that the v said "that doctor can do you no good!"

When it was explained to the patient that the noises proce from natural causes, such as the current of blood in the carotid ca

he was totally unable to disconnect them from the supernatural. When seen some weeks later, the condition of this patient was probably worse than when he was first seen. That the noises in the head had an unfavorable influence upon this case there can be no doubt.

CASE 5.—Mary D——, 38 years of age, came to the N. Y. Eye and Ear Infirmary in January, 1880. She is married and has had six children. Patient is a very tall and large woman, weighing over two hundred pounds. She states that her weight has been considerably greater, but that from poor living of late it has been reduced. In an altercation a week ago with a man, for whom she had done some washing, she received a blow upon the right ear with the fist, from the stunning effects of which she recovered in a few minutes to find that there was a noise, like escaping steam, in the injured ear, and that she was very dizzy. The tinnitus aurium has continued until the present time, and after the fourth day the vertigo was so great that she could no longer attend to her domestic duties. On the fifth day, there was a free serous discharge which she had not previously observed, and this gradually gave place to a copious one of a mucopurulent character.

The discharge is now tinged with blood and so free that a large pellet of cotton-wool soon becomes saturated with it, and it runs down the side of the neck. She had no medical attendance until the sixth day after the injury, when she was taken to a dispensary, where some medicament was put into the ear and the drums were inflated by means of an air-bag. She states that the local application seemed to irritate theear, and that the air douche increased the pains very much. The day following the above treatment she was brought to the author's clinic. Her condition then was as follows: She was very excitable, and feared to have the ear examined, but submitted after a little coaxing. The right ear was discharging freely, as has been stated. After this had been wiped out, it was found that the parts were so swollen that the precise point of rupture in the membrane could not be located. There was some swelling about the attachment of the auricle, and the parts were painful when touched. She has severe neuralgic pains in the temporal region. The first right upper molar tooth is very carious. Her voice was autophonous, and she could hear shouted words only in the affected ear. From her husband and herself the following facts were obtained. The night before her visit to the infirmary, she retired about nine o'clock, but was unable to sleep; she was restless, and obliged her husband to get up constantly during the night to look after the many hallucinations that occupied her mind. She required him to keep the window of the room open all night that he could watch the yard below, which she believed to be filled with people who sought to kill both herself and her husband. At times she fancied there were persons speaking from the walls—she would then stand for a while in a listening attitude. A man dressed in white came up out of the floor and stood near the door and held a club, as if about to strike; although a light was burning in the room at the time, she cannot recall seeing his face.

She also saw young women in white attire. The voices were not

recognized, excepting she fancied that among those in the ya could hear the voice of the man who struck her. and also the v his wife. She sometimes exclaimed to her husband: "There are coming up the stairs!"

She seemed to see objects flitting about, and when thi doubted, she would exclaim. "don't I see them!" These obje not seen during the day. She was afraid to remain alone, and the assistance of a policeman was required to bring her to th mary. It is stated that she has never experienced any mental tion nor have any of her relations. There was no dysacousma enced at this time or subsequently.

This patient remained under observation until February 26th which time she was not seen. For some time after her first vis sleep was accompanied by dreams of music, of ships and of s and the like, and it was more than two weeks before she ce experience the hallucinations.

The pain in the region of the ear was severe for ten days and time extended to other parts of the head. The discharge fro ear had almost ceased, she had but little tinnitus aurium o phony. the swelling of the external auditory meatus disappeare a small air bubble marked the seat of perforation at the inferi ment of the membrane tympani; the latter, however, was still tinguishable on account of its sodden condition. Hearing re so that she could hear loud voice, and the vertigo was very slig

Inasmuch as dysacousma was not a symptom in this case, it lieved that the brain itself was not greatly affected by the conc of the blow nor by an extension of the inflammation.

CASE 6.—The patient, an Irishman, 40 years of age, states t has long been of intemperate habits. He has been subject to throat" in the morning, to frequent headaches, and is nervou "shaky." He stated, when he came to the New York Eye an Infirmary in December, 1885, that seven months previously, a severe "spree," he had delirium tremens, and on recovery e enced annoying sounds in the left ear; persons either seemed "talking to him constantly" or there were sounds of voices i ear. At first he thought the voices heard were those of perso lowing him about "for the sake of a joke," but of late he be they may be due to some disease of the ear. As regards the tin he describes a "beating" sound in the ear synchronous wit cardiac pulsation, and a "buzzing." Sometimes there is low tling. There has been no annoying disturbance in the left ear. utterances heard are always profane or otherwise bad, and on "g himself up" to the delusion, he believes himself to be the subj abusive language. When he himself is not directly the subject vectives, he is still cognizant of a colloquy between two indivi on some other topic. He cannot escape from these unbidde famers at will, but sometimes the noises in his head are les nounced, and then the hallucinations are also less marked. A times he is less worried, and feels as though he "could control self" and throw the delusions off. There are times, however,

the voices do not din so unceasingly in the ear, but then he finds himself annoyed by knocks upon his door and steps in the hall; these sometimes arouse him up out of a semi-unconscious state with a shock. He often fancies "a party in the house is playing a game on him" with an electric battery; he can hear it "click," and "it nearly shakes him out of bed, and plays on his head like a hose." Then he is annoyed by speaking and whistling through a gas-pipe or tube coming up through the floor. Sometimes he "feels a kind of dizziness through the head." He has been to a police station about this trouble. He says the "voices" always remain outside the door. One of the "voices" is a heavy "bass" voice, the other is "high and squeaky," and may be a woman's or a boy's; they are comparatively as a "tin whistle to a cornet."

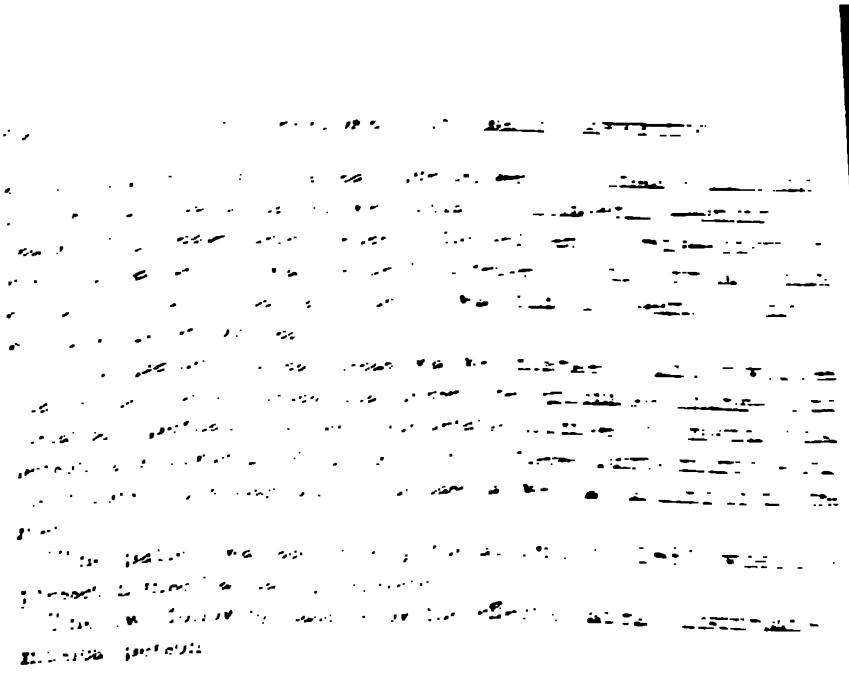
The patient's attention having dwelt on this matter, the phenomena have greatly increased in importance; he now hears the bass voice in the left ear, the tenor in the right one, whereas at first every sound seemed to enter the left ear.

There is no history of any previous disease of the ear. Syphilis is denied. He has chronic catarrhal inflammation of the upper air-tract (hypertrophic). The drum-heads are lustreless and somewhat atrophied; the anterior segment of both is dry and wrinkled. The left membrana flaccida is hyperæmic, and has a fleshy appearance. There are other evidences of loss of tension in the transmitting mechanism—thus there is general relaxation of the exterior parts of the ear, the skin in front of the tragus on both sides is notably relaxed, as is shown by several wrinkles. Inflation of the drum with the air-bag has caused the tinnitus to cease for ten or fifteen minutes; closure of the meatus seems to muffle the sounds heard. His own voice never sounds autophonously. Hearing is defective, ordinary voice only being heard distinctly at a distance of ten feet.

The patient was advised to find occupation, and when not at work to seek relief by keeping in the noise on the streets, etc., as much as possible. He found, however, that the noise of trucks, horse-cars, and other heavy vehicles made him worse, since the loudness of the voices heard was also increased. He noticed that he was much better after remaining a few days in the country.

A prominent neurologist, who saw the patient, considered that he had both insane delusions and hallucinations, due to some form of chronic cerebral disease arising from alcoholism, and that he was liable to become a dangerous lunatic. He found the tongue to point slightly to one side, and the pupils to be unequal. It was thought that the ophthalmoscope might throw more light on the case than could be gained from rational symptoms, and an examination was made. Although nothing decisive was found in the fundus, yet the vessels of the left eye had a suspicious look, the veins being very large in some places and considerably tortuous; these conditions might suggest commencing trouble from tumor of the brain or gummata.

Interest attaches to this case, not from disturbance of audition from central causation, but on account of the effect of the tinnitus



of high pitch like the oboe. The musical fancies were not all disagreeable, but the autophonia, hallucinations, and financial difficulties all together brought about a nervous state which for a time made life miserable in the extreme. On one occasion, he was induced to attend a concert, in the hope of diverting his thoughts into a more agreeable channel, but the music seemed discordant and was rather confusing than soothing in its effects; it finally became so painful as to be unendurable, and he fled from the room. Of late this patient has very much improved, and although he still has much tinnitus, and remains inconveniently deaf to conversation, hallucinations no longer exist, and the capacity for musical enjoyment has returned.

CASE 8.—Patient is a German, 72 years of age, and has been an accomplished teacher of music. He is now in his senescence, and experiences hallucinations in a remarkable degree. When first seen, in February, 1884, he gave the following history:

General health always fair, but has suffered from nasal catarrh, during exacerbations of which hearing for ordinary sounds was diminished, and autophonia was present and inability to distinguish the notes of a piano. During the past five years, he has had, at infrequent intervals, attacks of otalgia in both ears. The deafness has increased during the past year, obliging the patient to give up teaching, he being no longer able to detect the exact key of a note; "it would sound either sharp or flat." Both drum-heads give evidences of long-standing catarrh. Autophonia is well marked, tinnitus constant, and he hears only shouting voice, in both ears, at ten feet distance. It is found that he can distinguish harmony on the piano from discord when these different expressions are intensified so as to be well heard; but he fails to detect the difference between a full harmonious chord and one which is rendered slightly inharmonious by the introduction of one or more discordant notes. In respect to the patient's hallucinations, it may be said that they have been experienced, in some degree, for four years, but during the past year the musical experiences were especially marked. He states that, after composing a certain air, he then proceeds to play it on the piano, finishing the first two or three bars, and then stopping; the rest of the piece is then immediately completed by a full orchestra, apparently, and played through correctly. When alone in his room, familiar orchestral airs are heard at times; if any part is rendered incorrectly, it occurs to him at the moment "that was played wrong," when immediately the piece is repeated, this time correctly. Thinking of an air will at times suffice to produce either an instrumental or vocal rendering in the ears. He fancies that his daughter, who has been dead for a year, sings familiar airs to him. Ordinary street sounds, as the rumbling of trucks, stages, and horse-cars, sound musical, like the intonations and notes of a full orchestra. There are intervals after performing the Valsalvan experiment, or swallowing, when the street sounds above mentioned are entirely stopped. The patient makes the singular mistake of believing the tinnitus, etc., to be subjective or imaginary, whilst the musical tones and sounds made by fancied visitors from another world he believes to be actual.

CHAPTER XVII.

THE OPERATION OF EXCISION OF THE DRUM-HEAD AND OSSICLES.

The experience of the past decade in aural surgery has led to the fulfilment of the hopes of Sir Astley Cooper and other surgeons of the past, in respect to the relief of deafness by means of an operation which should admit sound to the fenestræ set in the wall between tympanum and labyrinth, by establishing a permanent opening in the drum-head. Otologists are thus enabled to avail themselves of the more accurate anatomical and pathological knowledge developed during the past twenty years, in adopting a radical plan of treatment in cases of chronic purulent and non-purulent inflammation of the middle ear.

From a long experience in the treatment of aural disease the writer felicitates himself, at least, in escaping from the ancient routine, almost limited, in chronic purulent processes, to the removal of polypi and the miscellaneous introduction of caustic and astringent medicaments into the external auditory canal, thereby temporizing with what often proved to be irremediable purulency.

Before proceeding further, it will be well to devote some space to the history of operations involving the extirpation of portions or the whole of the transmitting mechanism for the relief of otorrhœa and the improvement of hearing, up to the present date. Partial excision of the membrana tympani to improve the hearing was attempted many years since and in various ways, such as those recommended by Himly, Fabrizi, Brunner, Deleau, Bonnafont (1860). The chief difficulty, however, lay in the attempts at preserving the opening in the drum-head thus made. To accomplish this, Wreden proposed excising the manubrium mallei. The results of this procedure were in no respect more satisfactory than before. No greater success followed the attempts made by the application of various acids, the galvano-cautery, etc.

In Schwartze's work on the surgical diseases of the ear,[1] the author states that, since great damage to the hearing power does not necessarily follow loss of the malleus and incus in cases of chronic purulent processes, the idea suggests itself to remove these "otherwise *incurable obstructions to the transmitting mechanism of the drum and which lie externally to the stapes, arising mostly in fixation of the malleus and incus, by excision of these ossicles.*" (Italics the present writer's.)

Schwartze's first attempts at excision of the drum-head and extraction of the entire malleus in cases of sclerosis were made in 1873.[2] The results, though at first successful, were but temporary, owing to the rapid regeneration of the excised drum-head, which invariably followed.

The labors of J. Kessel, of Graz, in this direction are meritorious and should be alluded to at length. Aside from his experiments made to improve hearing by division of the adhesions, etc., surrounding the stapes,[3] Kessel reported in 1878[4] a case of removal of the drum-head, malleus, and incus in a patient suffering from chronic catarrh of the middle ear with closure of the Eustachian tube, as follows:

Male patient, aged 24 years. Closure of the Eustachian tube from catarrh of naso-pharynx. Hearing in right ear for conversation at fifty centimetres; in left ear for conversation at ten centimetres. Tinnitus very great and mostly in the left ear.

Right drum-head retracted; left inverted.

Operation: Left ear. Chloroform narcosis. Incision of drum-head with lance-shaped knife about its groove at the Rivinian segment and detached around its periphery. Tenotomy of tensor tympani and extraction of malleus. Drum filled with sticky, clear mucus. The incus and stapes had become displaced into the upper part of tympanum. Incus easily extracted. Stapes left in position. Hemorrhage slight. Patient heard voice immediately after the operation and tinnitus was less. Inflammation of the integument of the external auditory canal occurring during the following few days, caused decrease in the hearing power. On the sixth day hearing began to improve again, and in a month's time patient could hear whispered words at ten metres distance and the rain striking against the window panes. Tinnitus was slight, as was also the secretion from the drum. From this time on, however, relapse began; his hearing

[1] Die chirurgischen Krankheiten des Ohres. Dr. Hermann Schwartze. Stuttgart, 1885, page 279.

[2] Op. cit., p. 280.

[3] Archiv für Ohrenheilkunde, Vol. XI., 1876, p. 199.

[4] Archiv für Ohrenheilkunde, Vol. XIII., 1878, p. 69.

power diminished. In two months' time a thin newly formed membrane closed the opening into the drum, being adherent to the promontory. This was detached, the posterior portion of the bony and cartilaginous rings excised, in the hopes of preventing regeneration of the entire membrane, and maintaining an opening. Regeneration of the membrane. Two weeks later galvano-cautery applied to the cartilaginous ring, by which a small opening was maintained for two or three weeks. The membrane, however, closed again, becoming fast adherent to the promontory. Tinnitus slight. Patient heard voice at ten metres distance, but not as well as during the first month following the operation.

Kessel states that the result in five other cases was just the same as in the above, the incipient success being regularly destroyed by regeneration of the drum-head. The possibility, however, of maintaining an opening by the cautery induced him to continue the operation. He then proposed chiselling off the bony sulcus and the tendinous ring at the posterior segment, which he thought might remove the difficulty. Kessel recommended even the extraction of the stapes for certain conditions, and went so far as to do this in one case, his experiments on dogs and pigeons in 1871 having proved that removal of the stapes does not cause either vertigo or lesions in co-ordination, and that the deafness, present at first, disappears as soon as the oval window is closed by a newly formed membrane.

A paper read by Kessel in the tenth Monthly Meeting of the Society of Physicians in Steiermark, 27th October, 1879,[1] "On the Excision of the Drum-head and 'Mobilization' of the Stapes," contains further exhibition and exposition of results in a few new cases. He says that excision of the drum-head and "mobilization" of the stapes is indicated where the middle ear apparatus is immovable; in cases of closure of the Eustachian tube, total calcification of the drum-head with deafness, caries of the ossicles, ankylosis of the stapes, and distressing tinnitus, and cholesteatoma of the drum and the mastoid, when they cannot be removed in the usual manner.

Kessel's method of operating is as follows:

Narcosis. Drum-head, if present, excised around its periphery, including also in the posterior segment the tendinous ring, to prevent regeneration of tissues at that point. Tenotomy of tensor tympani. The loop of a snare now passed around the malleus handle and it, together with the detached drum-head, removed. If the incus be found healthy and the long process movable, it may be left in the drum. Kessel had operated in sixteen cases with no bad results. He gives the histories of the following three cases:

[1] Archiv für Ohrenheilkunde, Vol. XVI., 1880, page 196.

Male, 39 years of age. Fixation of ossicles. Complete deafness for voice. Distressing tinnitus. Some relief for the tinnitus afforded by the operation. Incudo-stapedial joint dislocated backward. Otorrhœa for a short time afterwards. Tinnitus ceased in six months. Gradual improvement in hearing. Parts dry.

Female, aged 23 years. Otorrhœa since childhood. Right drum-head gone; malleus retracted against promontory. No hearing for voice. Much tinnitus. Excision of remains of drum-head, malleus and incus. Discharge ceased in eight days. Tinnitus ceased permanently after the operation. Whispered words heard close to the ear; ordinary voice at one metre distance.

Male, 25 years old. Deafness and tinnitus since childhood; worse in left ear. Only vowels heard in left ear. Loss of memory; vertigo. Left drum-head opaque, thickened. Eustachian tube free. Excision of left drum-head and malleus handle (the latter broke off in the operation). The following day the voice was heard close by the ear. Less tinnitus. A discharge set in on the third day, and lasted for three weeks, during which the head of the hammer was probably cast out. Regeneration of the drum-head excepting in the posterior segment, where the ring was excised. Adherent to promontory. Tinnitus and other symptoms disappeared in six weeks. Conversation understood at several metres distance.

In an article[1] published by August Lucae in 1881, that author mentions a case of a female patient, suffering from the results of chronic catarrhal inflammation of the middle ear, upon whom he performed excision of the entire drum-head and malleus (left ear). The results of this procedure were entirely satisfactory to the patient who insisted upon a like operation being performed in the right ear. A continual high degree of sensitiveness to loud noises was noticed in both ears for some time after the operation. A large defect in the regenerated membrane remained. There was some reactive inflammation of the parts following the operation and some vertigo, all of which disappeared shortly, however. Hearing greatly improved, especially for musical sounds.

In a paper[2] read before the Section of Otology at the International Medical Congress, held in London, 1881, Lucae mentions the fact that he has performed excision of the drum-head with the malleus in twenty-five cases, in none of whom had any deterioration of the hearing power taken place; in some, on the contrary, a very considerable

[1] Ueber optischen Schwindel bei Druckerhöhung im Ohr. Archiv für Ohrenheilkunde, Vol. XVII., 1881.

[2] Zur physikalischen differentiellen Diagnostik zwischen Erkrankung des schallleitenden Apparates und Nerventaubheit. Mit Demonstrationen. Archiv für Ohrenheilkunde, Vol. XIX., 1883.

improvement in this. In 1883 the number of Lucae's operations exceeded forty.[1]

Prof. Schwartze, in reviewing the therapeutical value of this operation, says:[2] "*total* excision of the drum-head with the malleus may be *followed by permanent improvement of the hearing power* in cases of *total* calcification of the drum-head, and also in cases of fixation of the malleus due to ankylosis of the malleo-incudal articulation or adhesion of the malleus head to the upper wall of the tympanum, when no further obstruction to the transmission of sound to the auditory nerve is present in the windows of the labyrinth, etc." He recommends Kessel's method of removing the posterior portion of the tendinous ring, eventually also the chiselling off of the upper portion of the sulcus tympani, to prevent regeneration of the drum-head. "Nevertheless," he further states, "even when the excised drum-head is replaced by a membrane, closing the way to the labyrinth windows, a part of the improvement resulting from the operation, especially the cessation of the distressing tinnitus, may be permanent." He recommends total excision of the drum-head and hammer in cases of incurable chronic purulent inflammation of the middle ear, as one without danger, and frequently attended by success. Even when it afterwards becomes apparent that, besides the caries of the malleus, other parts of the middle ear tract are in a carious condition, excision is beneficial, inasmuch as by this means better escape for the secretions is afforded and the cavity of the drum made more accessible to treatment. Schwartze states that the general result of his own operative attempts incline him to the opinion that excision is followed by better results in cases of chronic purulency of the middle ear, or its residues, than in cases of sclerosis.

Schwartze gives the following as indications for the operation: Excision of the drum-head and ossicles is indicated in cases of chronic purulent inflammation of the middle ear with caries of the ossicles; furthermore, in cases of cholesteatoma of the tympanum. He says:[3] "non-cessation of the purulent discharge immediately after the excision would point to the existence of some other carious spot either in the tympanum or in the air-cells of the mastoid process. In the first instance, excision of the drum-head permits at any rate of a more careful diagnosis by means of the probe and the possibility of direct irrigation and cauterization of the diseased portion of bone; on the other hand, opening of the mastoid antrum, as a subsequent operation,

[1] Archiv für Ohrenheilkunde, Vol. XIX., 1883, page 75 (see foot-note).
[2] Op. cit., page 285.
[3] Op. cit., page 281.

would have to be considered. By means of the latter any retention of purulent matter and caries of the ear-chambers over the auditory canal, which connect with those of the mastoid process, would be made accessible to treatment."

This is practically what Kessel had already stated. (See p. 360.) Schwartze considers that the operation is indicated, furthermore, in cases of "fixation of the malleus resulting from total calcification of the drum-head or from ankylosis of the malleo-incudal articulation." "Hearing for the voice must be present; if whispered words are easily understood close to the ear, there is little probability of improving the hearing by the operation." In such cases excision of the entire drum-head together with the hammer may, according to the same author, permanently remove the tinnitus and improve the hearing power to such a degree that *whispered words* can be heard in the neighborhood of the ear.

"This is only possible when no calcification or other obstructions to the transmission of sound are present in the windows of the labyrinth."

"Excision of the malleus," he goes on to say, "is beyond all doubt of value in cases of *isolated* ankylosis of the malleo-incudal articulation without co-existing ankylosis of the stapes." The incudo-stapedial articulation should be divided, in order to avoid damaging the stapes, when removing the incus and malleus.

"The incus may remain without harm in the tympanum, if it does not come away easily. Since diagnosis of isolated ankylosis of the malleo-incudal articulation is so uncertain, it will be impossible to rely for a certainty on a good result from the operation."

Should excision of the drum-head with the malleus result in less being heard than whispered words close by the ear, after the reactive inflammation has subsided, obstructions to the transmission of sound other than fixation of the malleus must certainly exist.

The operation is indicated, furthermore, we are told, "in cases of closure of the Eustachian tube, as soon as it is shown that a probatory incision into the retracted drum-head results in a considerable improvement in the hearing power, with simultaneous return of the drum-head to its plane."

Schwartze's method of operating is as follows:

The degree of sensitiveness of the drum-head is first tested by the probe, and, if much reduced, as in cases of thickening, etc., narcosis will not be necessary. The head of the patient is held by an assistant, the auricle being pulled backwards and upwards. A deep narcosis will, however, be generally found necessary, especially in very nervous

patients. If the drum-head be much retracted, it will be well Politzer's air-bag to inflate the drum. The drum-head is close to its periphery, together with a portion of the cartila ring in the posterior segment. Tenotomy of the tensor tymp division of the incudo-stapedial articulation then follow, whe the excised drum-head together with the malleus are grasp the snare and extracted. The operation will be usually follo inflammation of the parts and otorrhœa, beginning during th twenty-four to thirty-six hours, and lasting for a week or e months.

Schwartze gives the histories of six cases operated by h Three of these patients were suffering from chronic purulent i mation of the middle ear, with caries of the malleus head. Al were males, aged respectively 36, 20, and 19 years, in whom t ease had existed for a long time. The results of the operat these cases were satisfactory, the otorrhœa ceasing entirely i six weeks to fifteen months' time. The fourth case is that of patient, 45 years of age, with the results of chronic purulent mation, fixation of the malleus, etc.

The distressing tinnitus was permanently and completely cu the operation. The improvement in the hearing power, ho which existed during the first six months after the operation, peared. In the last two cases the operation was undertaken improvement of hearing and relief of tinnitus; sclerosis of the head and ankylosis of the incudo-stapedial joint was present i patients. In one of them the cartilaginous ring was not e In both instances regeneration of the drum-head followed. T nitus was almost entirely cured in the one case, whilst in the no improvement in the subjective symptoms took place. In n was the operation followed by any improvement of hearing wor mention.

As has been already mentioned above, Lucae reported in 188 the number of cases in which he had performed this operati ceeded forty. In 1885 Lucae published a full report[1] of his w this direction up to that date, showing a total number of fifty operations performed in forty-seven patients, six times in both

In all of these cases the malleus was removed, in six patien incus also. He usually operated in chloroform narcosis; in five however, without any narcosis. Lucae says he undertook the

[1] Ueber operative Entfernung des Trommelfells und der beiden gr Gehörknöchelchen bei Sclerose der Paukenschleimhaut. Archiv für heilkunde, Vol. XXII., 1885.

tion at first only in those persons having a relatively good perception for high tones, but later on also in those patients where this was reduced or indeed quite absent.

Lucae's method of operating is the following :

By means of a lance-shaped needle a puncture is made in front of and behind the short process, then into these openings a sharp probe-pointed knife is introduced, with which the anterior and posterior halves of the drum-head are divided to its periphery, the two sections being then united by circular cuts. Tenotomy of the tensor tympani with Schwartze's tenotomy knife follows, and if the incudo-stapedial articulation is visible, he divides this also. To remove the malleus, he uses an instrument resembling a small lithotriptor, with which he is able to maintain a firm grasp on the ossicle. In a few of his cases he chiselled away a piece of the cartilaginous ring, after Kessel's method, partly in order to extract the incus, partly to expose the incudo-stapedial articulation. The latter was visible in only the smaller portion of his cases. Lucae is rather inclined to doubt the utility of Kessel's "mobilization," so called, of the stapes, having tried it in three cases apparently without any result. In one case he says he broke off both branches of the stapes.

Before operating he irrigates the ear with antiseptic fluids, and after the operation the parts are irrigated with a carbolized solution, iodoform being insufflated in some cases. The operation lasted but a few minutes. Otitis externa followed in some instances.

The results of Lucae's operations are very interesting and instructive. In 30 cases the adhesions, thickening of the tissues, fixation of the ossicles, etc., were found during the operation to be very considerable. Thirty-four patients had, when discharged, a larger or smaller opening in the regenerated drum-head ; in 17 the new drum-head closed entirely, and in 2 cases notes regarding this point were not made. Of the 34 cases where an opening in the regenerated drum-head remained, 10 had been under observation from one and one-quarter years to five years ; 24 under one year's time.

In 9 cases the improvement in the hearing power was very considerable ; in 19 it was slight, in 18 cases there was no improvement in hearing, and in 7 cases the latter became worse after the operation.

In the 28 cases just mentioned, showing more or less improved hearing, it was remarked that the highest tones were much better heard than the deeper ones. In 21 of these cases an opening in the newly formed drum-head remained ; in 6 entire closure took place, and in 1 case no notes were made of the condition.

In 8 cases the opening remaining in the regenerated drum-head was

In a later article [1] Kretschmann has, furthermore, reported six cases of excision of the drum-head and ossicles for the relief of the disagreeable subjective phenomena accompanying chronic purulent inflammation, especially of the tympanic attic with perforation of the membrana flaccida over the short process of the hammer. The results of the operation were very satisfactory in every instance, the foulness of the more or less pent-up secretions, the headaches, vertigo, tinnitus aurium, etc., being entirely relieved. In one case the malleus was not found and the incus was apparently not removed in all instances. For bringing this latter bonelet into view, Kretschmann employs a small instrument with a hook-shaped end, on the point of which is a small knob.

Stacke [2] (Erfurt) recently reported ten cases of removal of the malleus for chronic purulency of the middle ear, or its residues, and also in cases of chronic catarrh of the drum, for the relief of deafness, tinnitus, etc. All these cases show improvement in the hearing power (in some to a remarkable degree), or relief from distressing subjective phenomena (headaches, tinnitus, etc.). His first patient was operated in June, 1885. Six of his cases were males (one had both ears operated), three were females. The method of operating employed by this author resembles closely that of Schwartze, and he considers the use of antiseptic irrigations and dressings advisable.

In a paper [3] on aural vertigo, read before the Medical Society of the State of Pennsylvania, June 7th, 1888, Dr. Charles H. Burnett, of Philadelphia, reported a case where he performed excision of the drum-head, malleus, and incus, relieving the patient entirely from all of the very distressing vertiginous symptoms that had long existed.

The present writer has long known that, where the drum-head, malleus, incus, and the stapes, excepting perhaps its base, have been destroyed by suppurative action, followed by spontaneous cure, and leaving the entire tympanic cavity covered with a non-secreting membrane, very good hearing may remain. Some years ago, without knowledge of the work done in this direction abroad, it occurred to him that, were the structures, sometimes found remaining in the tympanum in a hopelessly diseased condition, removed by an opera-

[1] Fistelöffnungen am oberen Pole des Trommelfells über dem Processus brevis des Hammers, deren Pathogenese und Therapie. Archiv für Ohrenheilkunde, Vol. XXV., p. 165.

[2] Archiv für Ohrenheilkunde, Vol. XXVI., p. 115. See also Abstract of above by Dr. Chas. H. Burnett, American Journal of the Medical Sciences, Vol. XCVI., No. 1, July, 1888.

[3] Medical News, July 14th, 1888.

tion, otherwise irremediable cases of otorrhœa might speedily be cured.

In considering the indications for the operation of excision in chronic suppuration of the middle ear, the fact presents itself that, where the drum is encumbered with objects, now useless and diseased, but which once composed the transmitting mechanism, it is also often a reservoir for purulent secretions; in other words, the drum has lost its normal functions and has become a source of infection for the system. By excision, more or less obstruction to hearing is removed, and the septic influences are eradicated.

Where the membrana vibrans has lost, say one-half of its substance, either in large perforations or peripheral defects, and great deafness exists, though purulency be absent, an operation promises to improve hearing and prevent "gatherings" in the ear. Where, as a result of purulency, there are adhesive bands or ankylosis, causing great interference with the passage of sound, the operation is also indicated even when the drum-head remains. Of course, in both of the conditions just mentioned, where hearing in one ear remains good, the operation would only be advisable for the relief of noises in the ear; indeed, it may here be stated that subjective phenomena alone, in some instances, are so distressing that the operation for their relief seems justifiable even where good hearing exists.

In studying a large number of cases where destructive inflammation has left only a small portion of the conductive mechanism, no longer serving to aid in the transmission of sound, it is often found that this condition not only obstructs the entrance of sound, but the exit of secretions as well. Thus, where the membrana flaccida and a portion of the ossicular chain only remain, the former often becomes thickened, its free edge inverted, and forming, with the foldings of the altered mucous membrane, a pouch below the tympanic attic for the retention of putrescent matters which escape slowly; in some instances, by overflowing the pouch, in others, through fistulous openings in its outer wall, or via the Eustachian tube. In acute exacerbations from head catarrh, the means of escape for fluids become closed and hence the periodical "gatherings" which are a source of so much distress. Where granulation tissue or polypoid growths are present in the attic or antrum, drainage is still further interfered with. The irritation, both local and reflected to other regions, is almost indefinitely continued under the ordinary treatment in many of these cases.

The author's first operation was made early in 1886. This case (Case I. in the accompanying table), with others, was presented in a

paper read by him at the nineteenth annual meeting of the American Otological Society in July of the same year.[1]

The brilliant illumination afforded by a six-candle power incandescent electric lantern [2] is almost a necessity for the successful performance of this operation; besides, it affords protection from the danger of an explosion of the ether used in the narcosis.

The lantern, and band by means of which it is attached to the head when used in this operation, are shown in Fig. 53.

The patient should be placed on a restricted diet for some weeks previous to the operation; meat and stimulants should be forbidden,



FIG. 53.—The body of the lantern (outside diameter 1¼ inch, length 1½ inch.), is made of vulcanized fibre, a non-conducting and heat-resisting material, and completely incloses the six-candle power incandescent lamp. By this means the unpleasant glare from the light and the annoying heat (an extremely unpleasant feature with metal cases) are prevented. Heat ventilation is secured by the six or eight holes in the body, which are bored diagonally in a diverging direction. The cap on the top of the lantern protects the terminal wires of the lamp, the tip of the latter being protected by the lower cap. The lens is two-inch focus and one inch in diameter, which gives in this lantern the best illuminating effect at about eight to nine inches. The lens tubes are made of brass, and slide one in the other, each being about one inch in length.

and even tea, coffee, and tobacco used in moderation, if at all. This regimen should also be continued for some time after the operation.

[1] A New Operation for the Radical Cure of Chronic Purulent Inflammation of the Middle Ear Tract, by Samuel Sexton, M.D. Transactions of the Amer. Otol. Soc., 1886.

[2] The electro-motor power and lantern supplied by the River & Rail Electric Co. affords the most satisfactory light of any the author has seen.

The existence of a narrow and much curved external auditory canal interferes more or less with operative procedures. In cases where granulation tissue or polypi occupy the drum, success will follow sooner if the parts are first brought into a more healthful condition by local treatment. The writer at first undertook a number of cases exceedingly unfavorable in this respect, and found that where local inflammation was attended with free secretion and active proliferation, the results were not so satisfactory as where the parts had been previously treated. Moreover, where vascularity is great, the bleeding will obscure the field of operations.

It might be well to add, finally, that the operation will not be advisable during the menstrual period.

THE OPERATION IN CHRONIC PURULENT INFLAMMATION OF THE MIDDLE EAR.

The patient lies on his back upon a table so constructed that the head and back may be raised to a convenient elevation for the operator,



FIG. 54.

seated at the patient's head. The operating room is then darkened, and the electric current, illuminating the lantern, turned on. The first step in the operation consists in transfixing the membrana tympani behind the short process of the malleus with the trowel-shaped



FIG. 56. FIG. 55. FIG. 57. FIG. 58.

knife, as shown in Fig. 55. Then the same instrument, or a blunt-pointed narrow blade (Fig. 56) is swept around the margin of the tympanic ring posteriorly, detaching any remains of the drum-head in this direction. The same steps are then taken in detaching the anterior portion of the drum-head, the transfixion being in front of the short process, at which point the second incision is begun and completed by carrying the knife around anteriorly.

If the incudo-stapedial joint is intact and can be seen, it may be divided before these incisions are made. If this is not previously done, the detached tissues behind the malleus should be pushed aside in order to bring the parts into view, when the division of the joint mentioned may be accomplished. The angular bladed knives used for this procedure are shown in Figs. 57 and 58; two of these knives will be necessary, one for the right ear and one for the left. The incus, if in view, may now be removed with forceps. The malleus should then be freed from all of its attachments, such as tendinous connections, the tendon of the tensor tympani muscle, and adhesions arising from inflammatory processes, to as great an extent as possible, with the trowel shaped knife. It is then seized with stout dressing or foreign-body process as high up as possible, and by gentle traction gradually detached and brought away.

The parts may be cleaned of blood from time to time, as required, during the operation, with tampons of cotton wool wound on carriers, and kept ready at hand. If the malleus is seized near the umbo, in cases where the handle is brittle or the head or body is adherent, the bone may be broken off at some point below the short process. Sometimes only the long process of the incus comes into view after the malleus has been removed; if still attached to the stapes, it may now be separated from that bone, seized with forceps, and brought away. But where it has long been separated from the stapes, its removal is by no means always easy, since the long process may be absent, or, if remaining, the entire bone is liable to be displaced and lodged out of view upon the scute behind the margin of the tympanic ring. In other cases it becomes still more displaced backwards towards the antrum. The author is in the habit of searching for this bone, when concealed from view, with a long, stout silver probe, made for the purpose, and bent at about a right angle a quarter of an inch or less from one end, the bulb of the bent end being serrated deeply on the inner side. A magnifying glass is used from time to time to bring the whole region into better view. The removal of the incus is not difficult when brought down into view. Sometimes the malleus and incus are found adherent to each other, and come away together.

The writer first considered it necessary to divide the chorda tympani nerve in all cases before bringing away the two ossicles. He no longer does this, however, unless the nerve becomes entangled, and drawn down into view, an accident that he is now able to avoid in most instances.

The operation usually requires from ten to fifteen minutes for its performance after narcosis is complete. Frequently, however, less time is needed.

After the operation, the parts should be gently wiped out, and dried with cotton wool, avoiding syringing unless collections of inspissated pus are discovered. If pretty free bleeding continues, the fundus may be syringed out with water as hot as can be safely used. Pain is seldom experienced after the operation, but it may be relieved, if present, by the instillation of a few drops of a four-per-cent solution of cocaine hydrochlorate. Generally very little inflammatory reaction follows the operation, though, in some cases, infiltration of the wounded parts may be expected.

The accompanying table of cases shows the results, etc., of twenty-nine operations undertaken for the cure of chronic otorrhœa in twentyeight patients, in one case both ears having been operated.

Eleven of these patients were males, and seventeen females. The left ear was operated alone in 18 cases, the right in 9, whilst in 1 case both ears were operated.

In reviewing the *conditions* under which the operation was undertaken in these cases, it is found that in the great majority of them a very offensive discharge had long existed, together with a history of frequent "gathering and breaking" in the ear, often with invasions of acute head catarrh, where swelling of the drum gave rise to obstruction to drainage from the attic and antrum, the attacks being attended with severe pains in the ear. Usually the patients were very deaf and experienced distressing acoustic phenomena, as autophony and noises in the head and ears.

The *general health* of the patients was not good; most of them were from the run-down class found in hospital practice. The young children were generally nervous, peevish, cachectic, and poor sleepers, whilst the older ones were neurasthenic and subject to neuralgia about the head.

The pathological state of the drum in all cases was one of irremediable impairment of the transmitting mechanism.

Table of 29 cases of Excision of the Drum-head and Ossicles in Chronic Purulent Otitis Media.

Case	Age and Sex.	History.	Examination.	Operation.	Result.
1	Female 38 yrs.	Otorrhœa (left ear) for several years, with "gatherings," pain, headaches, etc. Patient is much exposed to cold draughts, and often has "a cold in the head."	Only a portion of the left drum-head remains in the posterior segment. Handle of malleus in position. Walls of tympanum are granular. Profuse discharge. Hearing: ordinary voice in left ear at about 5 feet.	March 24th, 1886. Ether. Excision of remains of drum-head. The denuded malleus and incus were removed without much difficulty. Hemorrhage slight.	*Cured.* Discharge ceased entirely in the course of the following two months. Parts perfectly dry and dermic. Hearing unchanged. General health better. Cessation of subjective symptoms.
2[1]	Female 27 yrs.	Otorrhœa (left ear) for 20 years. "Gatherings," pain, vertigo, headaches. Poor health	The upper portion of left drum-head only remains. Handle of malleus retracted and adherent to inner wall of drum. In the atrium considerable amount of granulations. Hearing: plain ordinary voice at 20 feet in left ear.	April 16th, 1886. Ether. The remains of drum-head detached and the malleus removed. Not much hemorrhage. The incus was then grasped with forceps, and came away easily. It was in a carious condition.	*Cured.* Discharge ceased entirely in 6 months. Atrium was dermic in appearance and dry. All subjective symptoms subsided, and her general health improved greatly. Hearing improved to low voice at 20 feet in the operated ear.
3	Female 19 yrs.	Otorrhœa (left ear) for past 10 years, consequent to scarlet fever. Vertigo and deafness. No pain or tinnitus aurium.	Only a fringe of the left membrana vibrans remains. The membrana flaccida is fleshy looking. Malleus visible. Hearing: loud ordinary voice only in left ear at 5 feet.	July 22d, 1886. Ether. Membrana flaccida detached. Malleus and incus, imbedded in membranous and granulation tissue, removed with difficulty. Profuse hemorrhage.	*Improved.* Reaction considerable. The discharge diminished, however, very considerably during the next 3 months, and when the patient was last seen, in January, 1887, it was very slight. Her general health had improved very much. Hearing unchanged.

[1] Case exhibited at the Meeting of the Practitioners' Society of New York, November 8th, 1886. See New York Medical Record, November 20th, 1886.

4	Male. 13 yrs.	Otorrhœa (left ear) since infancy. "Gatherings." Autophonia.	Membrana vibrans of left ear is almost entirely destroyed. Malleus handle projects downwards and backwards to inner wall of atrium. Cavity of drum is freely exposed; contains no granulations. Hearing: ordinary voice in left ear at 5 feet.	July 30th, 1886. Ether. Detachment of membrana flaccida, and excision of malleus and incus. Slight hemorrhage.	*Cured.* Discharge ceased in a few weeks. No return of headaches, "gatherings," etc. Hearing showed no change
5	Female 5 yrs.	Otorrhœa (left ear) for 1 year, consequent to scarlet fever. "Gatherings," headaches, pains in the ear.	Membrana vibrans of left ear entirely gone. A portion of malleus and incus visible. Hearing: ordinary voice at 5 feet in left ear.	Aug. 10th, 1886. Ether. The membrana flaccida detached, and malleus and incus removed. The bony scute was found roughened and was scraped.	*Cured.* Discharge had ceased by Aug. 25th, 1886. In October, 1886, the cavity of the drum was whitish in appearance, dermic, and perfectly dry. When patient was seen in March, 1887, the same condition was present. No return of "gatherings." Hearing apparently unchanged.
6	Female 6 yrs. (See case 19.)	Otorrhœa (both ears) for about a year. "Gatherings," pains. Dentition. General catarrh of upper air tract. Nervous subject, irritable.	*Right ear.* A polypoid growth presents through a perforation in the membrana flaccida. The membrana vibrans is nearly all gone. Handle of malleus lies backwards, adherent to inner wall of drum.	Aug. 12th, 1886. *Right ear.* Ether. Detachment of membrana flaccida. Malleus and incus removed with difficulty owing to attachments. Profuse hemorrhage.	*Cured.* Complete dermic transformation of membrane lining drum in 60 days. No more "gatherings" in this ear, or pains. General health improved somewhat.
7	Male. 16 yrs.	Otorrhœa (right ear) for past year and a half. No cause known. Vertigo at times and pain.	The right membrana vibrans is entirely destroyed. Malleus is visible. The walls of atrium are granular in appearance.	Aug. 18th, 1886. Ether. The membrana flaccida detached. Malleus and incus were bound down firmly by thickened tissue, and much difficulty was experienced in removing them. There was profuse hemorrhage.	*Cured.* By Oct. 4th, 1886, the discharge had ceased entirely. Hearing was unchanged.

Case	Age and Sex.	History.	Examination.	Operation.	Result.
15	Female 8 yrs.	Otorrhœa (both ears) for past 5 years. Suffers much from headaches.	The membrana vibrans of the *right* ear is largely destroyed. The *left* drum-head is entirely destroyed, and a large polypus occupies cavity of drum. Hearing in right ear: ordinary voice at 5 feet.	Nov. 3d, 1886. Ether. The membrana flaccida of *right* ear detached. Malleus and incus removed. Pockets formed by bands of cicatricial tissue and folds of mucous membrane cleared away with probe.	*Cured.* Discharge ceased entirely in 7 weeks, and the cavity of drum presented a dry, dermic appearance. Hearing improved in operated ear to low ordinary voice at 5 feet.
16	Female 25 yrs.	Otorrhœa (both ears) and "gatherings" for 20 years. General health is very poor.	Only a fringe of the *left* drum-head remains in the posterior segment. A portion of the malleus is visible. The *right* drum-head presents a large perforation in its centre, the rest of the membrane being cicatricial looking. Malleus retracted. Hearing in left ear: ordinary voice at 5 feet.	Nov. 10th, 1886. Ether. The *left* membrana flaccida detached, and the malleus and incus, united by ossification, were removed. Attic carious.	*Cured.* Discharge ceased by April, 1887. General health much better. Hearing unchanged.
17	Male. 20 yrs.	Otorrhœa (left ear) for 7 years, consequent to scarlet fever.	Left drum-head is entirely destroyed, excepting a small fringe in the anterior-superior quadrant. Hearing in left ear: only shouting voice at 12 feet.	Dec. 9th, 1886. Ether. Remains of drum-head detached, and a small portion of a necrosed ossicle (incus?) removed.	Patient passed from under observation, and no report of any result was obtainable.
18	Male. 8 yrs.	Otorrhœa (left ear) for 5 years, after scarlet fever. "Gatherings." Discharge profuse and very offensive.	Large loss of substance in left membrana vibrans. Malleus handle visible. Caries of attic. Hearing in left ear: ordinary voice at 10 feet.	Dec. 23d, 1886. Ether. The remains of membrana vibrans and membrana flaccida detached. Malleus (denuded) removed. Incus absent.	*Improved.* No return of "gatherings." Continuation of discharge due to diseased state of bone. Hearing power unchanged.
19	Female 6 yrs.	See history of Case 6 (same patient).	*Left ear.* A portion of the membrana vibrans remains. Membrana flaccida is fleshy looking. Atrium granular and contains much pus.	Dec. 23d, 1886. Membrana flaccida detached. Malleus removed with difficulty, as it lay crosswise through the atrium. Incus absent. Slight hemorrhage.	*Improved.* The ear still discharges, and patient is yet under treatment. Atrium is free from granulations. No pain or other subjective symptoms

11	Female 18 yrs.	Otorrhœa (left ear) for past 15 years. Mastoid disease. Headaches. Tinnitus. Granulations removed frequently.	A large sinus leading from behind left auricle into mastoid antrum is present, through which purulent secretion oozes. Membrana vibrans entirely gone. Malleus is visible. Atrium filled with granulations. Caries of attic. Hearing: left ear, ordinary voice at 5 feet.	Sept. 1st, 1886. Ether. Remains of membrana flaccida detached. The malleus (carious) then extracted. Atrium scraped of granulation tissue. Incus absent.	*Improved.* The discharge diminished very much during the following 6 months, and its continuance is due to the carious state of the bone. The subjective symptoms have subsided, and patient's general health has improved. She is still under treatment.
12	Male. 11 yrs.	Otorrhœa (left ear) for past 5 years. Discharge bloody at times, and very offensive. Pains frequently. Autophonia.	The left membrana vibrans is entirely destroyed. Malleus visible; it hangs well down into atrium. Hearing in left ear: ordinary voice at 3 feet.	Sept. 1st, 1886. Ether. Excision of membrana flaccida. Malleus and incus (both carious) removed. Slight hemorrhage.	*Cured.* Discharge ceased in 8 weeks. Inner wall of atrium was lined with whitish, glistening tissue and perfectly dry. Hearing in operated ear improved to low ordinary at 3 feet.
13	Female 12 yrs.	Otorrhœa (both ears) for past 4 years. History of headaches, "gatherings," vertigo. Poor health.	Only a rim of the posterior segment of *left* drum-head remains Anteriorly the membrane is cicatricial. Malleus handle lies back, adherent to inner wall of atrium. *Right* drum-head entirely destroyed. The walls of drum are dermic. Hearing in left ear: loud ordinary voice at 10 feet.	Oct. 25th, 1886. Ether. Remains of *left* drum-head excised, and malleus removed. The incus was absent.	*Improved.* "Gatherings," headaches, and other subjective symptoms subsided. Discharge at present very slight. Hearing is unchanged.
14	Male. 8 yrs.	Otorrhœa (left ear) since infancy. Subject to "cold in the head," hypertrophied tonsils, etc. Much secretion from nasopharynx.	The anterior quadrant of left drum-head is destroyed. Atrium is granular. The denuded malleus remains with portions of the posterior segment attached. Hearing in left ear: ordinary voice at 5 feet.	Oct. 30th, 1886. Ether. Remains of left drum-head excised. Malleus and incus removed. Hemorrhage slight.	*Improved.* Discharge reduced to a minimum in 3 weeks. Patient, as stated, takes cold easily and frequently, and when this happens the discharge increases again. Hearing has improved to low ordinary voice at five feet.

Case	Age and Sex.	History.	Examination.	Operation.	Result.
24[1]	Female 17 yrs.	Otorrhœa (both ears) for 5 years, consequent to scarlet fever. "Gatherings," headaches, etc. For past 3 months no discharge.	Both drum-heads are cicatricial. A large opening remains in the *left* drum-head, anteriorly, leading into attic. Parts are dry. Hearing in left ear: only very loud or shouting voice at at 10 feet.	Aug. 4th, 1887. Ether. *Left* ear. Membrana flaccida detached and malleus removed. Incus absent. Slight hemorrhage. N. B.—The operation was undertaken in this case for the relief of deafness alone.	*Cured.* The discharge, occurring after operation, ceased in 8 weeks. The hearing improved to ordinary conversation voice at 20 feet in the operated ear.
25	Male. 16 yrs.	Otorrhœa (left ear) for 10 years; headaches, etc. Poor health. Nervous subject.	A portion of the left drum-head remains. Atrium filled with masses of polypoid tissue. Caries of attic. Many adhesions. Hearing in left ear: ordinary voice at 10 feet.	Aug. 18th, 1887. Ether. Remains of drum-head detached. Malleus and incus removed with difficulty owing to adhesions. Slight hemorrhage.	*Improved.* Discharge is now very slight, and patient's health has improved greatly. The headaches and other painful subjective phenomena have subsided. Hearing unchanged.
26	Female 18 yrs.	Otorrhœa (right ear) for 6 years. Poor health. Nervous, irritable subject. Headaches, vertigo, pain, "gatherings" in ear.	Only small fringe of the right drum-head present, and a small stump of the incus seen. Malleus absent. Caries of attic. Large mass of polypoid tissue. Hearing in right ear: ordinary voice at 10 feet.	Aug. 18th, 1887. Ether. The remaining portion of the right drum-head excised, and the stump of incus removed.	*Improved.* The painful symptoms have, for the most part, subsided. Continuation of discharge due to carious condition of the bone. Hearing unchanged. Patient still under treatment.
27	Female 22 yrs.	Otorrhœa (both ears) for past 15 years, with "gatherings" and much pain at times.	Only the upper portion of the *left* membrana vibrans remains. The *right* atrium presents a dry, dermic appearance. Hearing in left ear: loud voice at 10 feet.	Aug. 18th, 1887. Ether. The membrana flaccida of *left* ear detached. Malleus and incus removed with difficulty owing to cicatricial tissue. Hemorrhage slight.	*Cured.* Discharge ceased in 8 weeks. Hearing improved to ordinary voice at 10 feet in operated ear. General health much better.

[1] Case 24 was exhibited at the Meeting of the Practitioners' Society, December 2d, 1887. See N. Y. Medical Record, December 31st, 1887.

20	Male. 23 yrs.	Otorrhœa (right ear) for 10 years, consequent to bathing. "Gatherings," pains, tinnitus, vertigo. Nervous subject in run-down state of health.	Right membrana vibrans absent. Handle of malleus lies directly back, adherent to inner wall of atrium. Free opening into attic. Atrium contains some granulations. Hearing in right ear: loudest voice not heard at 5 feet.	Jan. 25th, 1887. Cocaine (4%). Membrana flaccida detached, and malleus removed. The incudo-stapedial articulation found destroyed. Four days later, under nitrous oxide gas, incus removed.	*Cured.* There was immediate improvement in the hearing power, ordinary conversation being heard at 5 feet, loud voice at 20 feet. A month later, ordinary voice could be understood at 22 feet. Discharge ceased in 3 months. General health much improved. No return of "gatherings," etc.
21	Male. 9 yrs.	Otorrhœa (right ear), "gatherings," headaches, for 7 years.	Drum-head of right ear destroyed entirely. A stump of the malleus is visible. Hearing in right ear: ordinary voice at 5 feet.	July 2d, 1887. Ether. Excision of membrana flaccida. Malleus removed. Incus absent.	*Improved.* Entire cessation of painful subjective symptoms. Discharge is now slight. The attic contains much granulation tissue. Hearing unchanged.
22[1]	Female 18 yrs.	Otorrhœa (right ear) for 9 years. History of headaches, "gatherings," vertigo. Run-down subject. Nervous irritability attributable to disease.	The right canal is occluded by a false membrane, situated at about three-quarters of an inch within, thinner in its centre, and having an opening the size of a pin's head in its lower portion. Through this opening some purulent matter oozes. Hearing in right ear: plain ordinary at 10 feet.	July 7th, 1887. Ether. Excision of cicatricial membrane. Malleus and incus removed. Slight hemorrhage.	*Cured.* Discharge ceased entirely in 7 weeks. No reproduction of membrane. Total cessation of painful subjective symptoms, and great improvement in general health. The hearing has improved to ordinary voice at 20 feet in operated ear. Drum dry and dermic.
23	Male. 27 yrs.	Otorrhœa (both ears) for 10 years. "Gatherings," headaches. Nervous and run down in health.	There is a large loss of substance in the *left* drum-head. Malleus handle retracted to inner wall of drum. The *right* ear is in a similar condition.	July 18th, 1887. Ether. Membrana flaccida of *left* ear detached. Malleus and incus, imbedded in thick cicatricial tissue, removed with difficulty. Hemorrhage considerable.	*Improved.* Almost entire cessation of discharge. Painful symptoms subsided. Hearing unchanged.

[1] Case 22 was exhibited at the Meeting of the Practitioners' Society, December 2d, 1887. See N. Y. Medical Record, December 31st, 1887.

Case	Age and Sex.	History.	Examination.	Operation.	Result.
24[1]	Female 17 yrs.	Otorrhœa (both ears) for 5 years, consequent to scarlet fever. "Gatherings," headaches, etc. For past 3 months no discharge.	Both drum-heads are cicatricial. A large opening remains in the *left* drum-head, anteriorly, leading into attic. Parts are dry. Hearing in left ear: only very loud or shouting voice at at 10 feet.	Aug. 4th, 1887. Ether. *Left* ear. Membrana flaccida detached and malleus removed. Incus absent. Slight hemorrhage. N. B.—The operation was undertaken in this case for the relief of deafness alone.	*Cured.* The discharge, occurring after operation, ceased in 8 weeks. The hearing improved to ordinary conversation voice at 20 feet in the operated ear.
25	Male. 16 yrs.	Otorrhœa (left ear) for 10 years; headaches, etc. Poor health. Nervous subject.	A portion of the left drum-head remains. Atrium filled with masses of polypoid tissue. Caries of attic. Many adhesions. Hearing in left ear: ordinary voice at 10 feet.	Aug. 18th, 1887. Ether. Remains of drum-head detached. Malleus and incus removed with difficulty owing to adhesions. Slight hemorrhage.	*Improved.* Discharge is now very slight, and patient's health has improved greatly. The headaches and other painful subjective phenomena have subsided. Hearing unchanged.
26	Female 18 yrs.	Otorrhœa (right ear) for 6 years. Poor health. Nervous, irritable subject. Headaches, vertigo, pain, "gatherings" in ear.	Only small fringe of the right drum-head present, and a small stump of the incus seen. Malleus absent. Caries of attic. Large mass of polypoid tissue. Hearing in right ear: ordinary voice at 10 feet.	Aug. 18th, 1887. Ether. The remaining portion of the right drum-head excised, and the stump of incus removed.	*Improved.* The painful symptoms have, for the most part, subsided. Continuation of discharge due to carious condition of the bone. Hearing unchanged. Patient still under treatment.
27	Female 22 yrs.	Otorrhœa (both ears) for past 15 years, with "gatherings" and much pain at times.	Only the upper portion of the *left* membrana vibrans remains. The *right* atrium presents a dry, dermic appearance. Hearing in left ear: loud voice at 10 feet.	Aug. 18th, 1887. Ether. The membrana flaccida of *left* ear detached. Malleus and incus removed with difficulty owing to cicatricial tissue. Hemorrhage slight.	*Cured.* Discharge ceased in 8 weeks. Hearing improved to ordinary voice at 10 feet in operated ear. General health much better.

[1] Case 24 was exhibited at the Meeting of the Practitioners' Society, December 2d, 1887. See N. Y. Medical Record, December 31st, 1887.

28	Female 17 yrs.	Otorrhœa (left ear) since infancy. Subject to "colds in the head," frequent "gatherings" in the ear, with much pain.	The left drum-head entirely destroyed. Round window three-quarters visible. Attic contains granulation tissue. Incus visible. Hearing in left ear: plain low voice at 5 feet.	Sept. 26th, 1887. Ether. Membrana flaccida (remains of) detached, and body of incus removed. Malleus absent.	*Improved.* Discharge had greatly diminished in 9 days. On the eleventh day she could hear moderately low voice in the operated ear at 20 feet distance. Almost well when last seen, May, 1888.
29	Female 13 yrs.	Otorrhœa (right ear) for many years. Measles. Headaches. Pain in ear. Nervous child.	The right membrana vibrans is destroyed. Stump of malleus lies back against inner wall of drum. Hearing in right ear: ordinary voice at 5 feet, loud voice at 10 feet.	Oct. 6th, 1887. Ether. Remains of drum-head detached. Malleus removed. Incus absent. Slight hemorrhage.	*Improved.* A slight secretion still exists. Hearing has improved slightly. Her general health is better. Still under treatment.

The existence of chronic purulent inflammation of the attic and antrum with a sinus leading out through the upper margin of drum-head, where discharge and deafness are slight, does not always call for excision of the ossicles. But chronic purulency of these parts that has resisted other methods of treatment for months or years, together with loss of the greater portion of the membrana vibrans and consequent deafness, are conditions that the operation will nearly always relieve and generally cure so far as the otorrhœa is concerned.

In most of the cases under discussion the membrana flaccida was almost the only portion of the drum-head remaining. In some cases, however, bands, consisting in part of the remains of the m. vibrans and in part of cicatricial tissue, were found extending in various directions from the tympanic ring, m. flaccida and malleus, binding the dismantled transmitting apparatus together or to the inner wall of the tympanum. In the larger number of cases, the remains of the ossicles and cicatricial structures just alluded to were found adhering to the inner wall of the drum in such a way as to prevent drainage from the attic and antrum during "gatherings," though the small sinus usually present was sufficient for the escape of the ordinary secretion of these parts.

The malleus and stapes were generally present, being held firmly in place by ligamentous and membranous attachments. The incus was less constantly found and its attachment to the stapes seldom remained.

The malleus, or portions of it, was usually quite firmly held in the drum, even after the most destructive or long-continued suppurative action.

In 19 of the above recorded cases the malleus and incus were both removed; in 7 cases the malleus alone was extracted, whilst in 3 cases only the incus was removed. In many cases the malleus handle had been party destroyed by caries, a stump only remaining, in some instances denuded, in others enveloped in thickened tissues. Sometimes the handle was covered with white and glistening cicatricial tissue. In most instances the incus was also more or less affected by caries. The articular surfaces of the ossicles were generally abnormal; very often ankylosed to each other.

The incus seemed adherent to the scute in some cases—though a doubt was entertained as to whether this bone might not have been absent, the parts being beyond the range of vision and explored by means of a probe, which, in touching the exposed and roughened surface of the scute, gave a rather uncertain impression. In one case the neck of the malleus was firmly adherent to the auditory plate.

The condition of the stapes cannot always be determined, since it is impossible to examine it in situ in all cases; it is, however, probably very often much injured.

The tympanum was sometimes almost filled with granulation tissue or polypoid growths of greater or less size, and the mucous membrane lining the parts was often greatly thickened. Secretions were very abundant where such pathological conditions also existed in the antrum and neighboring cellules, especially when these deep lying cavities were large.

In some of the cases, the drum-head was the seat of a large heart-shaped perforation, leaving a narrow rim attached to the tympanic ring all round it.

The walls of the middle ear tract were seldom entirely free from caries, especially the upper surface of the scute.

A peculiarity of the denuded surfaces in this region is the white and glistening appearance of the cicatricial tissue which is substituted for the periosteal surface when healing has taken place.

Where extensive adhesions and greatly thickened tissues were cut away, the discharge immediately increased for a time, and occasionally there was some tenderness of the tissues for several days. Generally the discharge gradually decreased, and then ceased altogether, leaving a non-secreting, dermoid surface lining the entire middle ear tract as far as could be seen.

The result in these 29 operations may be summed up as follows: 15 were cured and 13 improved, whilst 1 patient (Case 17) passed from under observation after the operation, and nothing concerning the result in his case has been ascertained. Of the 15 cases where a cure occurred, this result took place:

In 2 cases within one month (Cases 5 and 8).[1]

In 9 cases within two months (Cases 1, 4, 6, 7, 12, 15, 22, 24, 27).

In 2 cases within three months (Cases 9 and 20).

In 2 cases within six months (Cases 2 and 16).

In the larger number of the thirteen cases noted as improved, this improvement was slight, owing to a carious condition of the bony walls, etc., of the immediate region, and some of them were under treatment

[1] The author desires to call attention to an error occurring in his paper on "Excision of the Ossicles, etc.," printed in the Trans. of the American Otological Society, 1887. In the table of results, namely, given on page 86 of that volume, five cases are reported as cured within one month, and two cases within two months' time. The mistake in these numbers was owing to an oversight, not discovered in time to correct them; the figures should be reversed.

a long time. In the greater number, the improvement consists in more or less decrease of the discharge, but principally in the cessation of the pain, "gatherings," and headaches.

A marked improvement in hearing occurred in consequence of the operation in eleven of these cases. The degree of improvement in this respect in each case may be seen by consulting the table given. In some it was quite remarkable, and it may be fairly estimated that the gain in hearing power was from seventy-five to one hundred *per cent* or more, as tested by the voice. Hearing was also improved for the watch and other high-pitched sounds. The hearing power was not always notably increased immediately after the operation, but improved gradually as a cure was established.

This marked improvement in hearing was quite unexpected by the author, and gave rise to the conviction that the operation may be recommended for deafness alone in many cases where the drum is obstructed by the results of chronic purulent inflammation, though all discharge may have ceased.

Case 24, undertaken for the relief of deafness, is a good example of this kind. The patient, a young dressmaker, who had lost a situation on account of deafness, was, owing to the result obtained by the operation, enabled to resume her work.

The sense of taste was more or less affected in those cases where the chorda tympani had been divided in the operation; recovery, however, always took place in a short time. In many of the cases the nerve had been previously impaired or totally destroyed by suppurative inflammation.

Reproduction of the drum-head did not take place in any of the cases.

General health was nearly always much improved; in two phthisical subjects the cough lessened in one and ceased altogether in the other, whilst both gained much in strength and weight.

In children the good effect on health was very marked; anorexia, restlessness, febrile movements, etc., which previously existed, ceased after the operation. Indeed, this would be expected on the cessation or abatement of otorrhœa and earache.

In short, the important results of excision of the remains of the transmitting mechanism of the ear are the *prevention of recurrent accumulations* of mucous or purulent matter in the attic of the antrum, the *cure of otorrhœa* together with the *relief of the attendant pain, deafness, and distressing acoustic phenomena.*

In regard to after-treatment, it is important to keep up the patient's general health, and to as great an extent as possible strive

to abate any inflammatory (catarrhal) disturbances of the naso-pharynx and middle ear tract. Carious teeth should, if greatly damaged or "dead," be removed. In several of the author's cases, the cure was greatly delayed by the presence of diseased ("dead") teeth, causing reflected irritation.

Where caries of the osseous structure of the middle ear tract exists, or where a large pathological cavity comprising the attic, antrum, and cellules is lined with an actively secreting surface, the treatment must be directed to keeping down granulation tissue whilst the transformation of the mucous lining to a dermoid condition takes place. In some very much run-down persons, all treatment may, for a time at least, prove unavailing, but "gatherings" no longer occur, since drainage is no longer interfered with. In one case, under most unfavorable conditions, whilst drainage remained good, purulency continued and granulation tissue refilled the attic in a short time after the operation. Some bands, moreover, subsequently were found to connect the tissues on the upper margin of the tympanic ring with the inner wall of the tympanum.

Active measures should be avoided at first, but later on salicylic or boracic acid powder may be employed. The peroxide of hydrogen has its use in some cases. Alcohol has not been found useful in keeping down granulation tissue in these cases. The persistency of discharge after the operation usually depends upon a general catarrhal condition of the upper air-tract in cachectic subjects, especially where caries of the bone exists.

The operation has a wide field of usefulness among the so-called deaf-mute class. Many of these persons in whom treatment has been abandoned, especially after cessation of the otorrhœa, could doubtlessly be restored to much better hearing.

THE OPERATION IN CHRONIC NON-SUPPURATIVE (CATARRHAL) INFLAMMATION OF THE MIDDLE EAR.

The author, having found that hearing was greatly improved in some of the cases where the surgical procedures described above had been undertaken for the relief of otorrhœa, decided to extend its benefits to cases of deafness, vertigo, and noises in the ears, especially when occurring in sclerosis of the transmitting mechanism.

Believing that in certain cases deafness was due to rigidity from ankylosis in some part of the ossicular chain of the transmitting mechanism, he concluded to make a free opening with sulphuric acid in the posterior-superior quadrant of the drum-head, exposing the

incudo-stapedial joint, which could then be disarticulated. Accordingly, several patients were treated in this manner, the opening in the drum-head being allowed afterwards to close up. In order to prevent a reunion of the disunited surfaces, the end of the long process of the incus was amputated. (See Fig. 59.)

Hearing and noises in the ear were found to be much relieved by this operation, but on closure of the opening in the drum-head, deafness was almost as great as before, though the relief of the subjective symptoms remained.

In one instance (see Case 30), however, operated in November, 1886,



FIG. 59.—The Author's Instrument for amputating the long process of the incus, consisting of a small steel canula, fastened to a handle at nearly a right angle, and having a ring-like end. This ring or loop is slipped over the long process, when amputation is accomplished by pushing forward the knife (which slides concealed in the canula), by making pressure with the thumb on the knob. The action is somewhat similar to that of a tonsillotome.

in which the transmitting mechanism was thus set free, so to speak, the opening remaining, the result was so brilliant that the writer was encouraged to perform the operation of excision of the drum-head, malleus, and incus, in the hope that preventive measures might be taken against a reproduction of the drum-head. Profiting by his own experience in operations on the ear, as well as that of other aural surgeons, he has met with greater success than could have been hoped for.

The indications for the operation comprise great impairment of the functions of the transmitting mechanism from chronic inflammation (catarrhal) of the drum, or as a result of acute suppurative or non-suppurative action in the organ; whereby the mechanism no longer facilitates sound transmission, but is rather a hindrance thereto. The degree of deafness for the relief of which we may operate differs somewhat in each case, the conditions of age and occupation influencing patients variously.

Persons who cannot distinguish words in conversation of a loud tone at one or two feet distance, without the aid of lip-reading, may generally be benefited by the operation. These would, according to the writer's experience, be able to hear after the operation ordinary conversation at from two to twenty feet, according to circumstances. Hearing for voice, after excision of the transmitting mechanism, improves more in respect to cognizance than to definition, so to speak; thus plainly spoken words are heard almost as well at twenty feet as at ten feet, but whilst heard more loudly they are not proportionally so well understood. The gain, however, in some instances is much greater than this. Persons having their hearing considerably restored by the operation are liable to soon forget how great the improvement has been, but in some instances, where reproduction of the drum-head has occurred and the patient has lapsed into the same state as before the operation, the return of deafness has been keenly felt. In advising the operation, it is well to explain in detail how little may sometimes be gained; yet how important that little may be is shown, as just stated, by its sudden loss again. Where deafness is progressive, we may confidently expect to arrest its progress, *i. e.*, to judge from the cases already observed, the progress of chronic inflammation ceasing after the mucous membrane of the drum undergoes dermic transformation.

The writer has been forced to the conclusion that, on removal of the drum-head, malleus, and incus, sound enters the labyrinth through either or both windows, since he has witnessed great improvement from an opening made in the drum-head without separation of the incus from the stapes. But inasmuch as no way is at present known of ascertaining beforehand whether fixation of the stapes exists in any given case, it is advisable to separate this bonelet from the incus after perforation.[1]

[1] The author has a case under observation where the incudo-stapedial articulation was left intact after removal of the posterior segment of the drum-head, in which hearing is much improved; he hopes, by disarticulating this joint, soon to be able to decide whether the round window alone will admit sound waves in this case.

The writer's experience in operating for the relief of subjective symptoms only is more limited. It has been found, however, that, where they existed, vertigo and noises in the ear have been alleviated or cured entirely by excision. Where very great relaxation of the transmitting mechanism exists, giving rise to severe autophonia, noises, vertigo, etc., the operation would, therefore, seem to be indicated. As a rule, it is probable that the earlier in life, as well as earlier in the disease itself, the operation is done, the more successful it will be.

Method of Operating.—The operative procedures in chronic (catarrhal) inflammation of the middle ear are somewhat similar to those described for otorrhœa. The author's first method differed from that of the German surgeons in several particulars. A small quantity of *acidum sulphuricum*[1] (less than a drop) was first applied to the posterior segment of the drum-head, by means of a minute mop of cotton-wool wound upon the end of a silver or aluminium probe. Then, with a silver probe, the cauterized area was quickly broken down, thus making a large opening without any hemorrhage to obscure the parts, and render the next step of the operation, which is one of delicacy, difficult. He now, however, detaches the drum-head by simple incision all around, leaving the flaps attached to the handle of the malleus. The incudo-stapedial articulation is then divided with the knives shown in Figs. 57 and 58. This is usually accompanied by quite a loud and distinct "click," and leaves the detached end of the long arm of the incus in view. A bent silver probe should now be passed behind the long arm of the incus to make sure of its separation from the stapes. If the probe be gently passed over its surface, and some of its envelope detached, it will generally present a glistening, white appearance, and is thus easily distinguishable. It may now be brought down with forceps, on slight traction being made. The remaining attachments of the drum head should then be separated with the knife shown in Fig. 55, and, together with the malleus, removed, as in the previously described operation for purulency. The writer formerly did not remove the incus, as mentioned above, until after the drum-head and malleus had been taken away. Finding, however, that the latter procedure was liable to displace the incus, which could not afterwards be found, he has, of late, removed the incus as above described. In some cases, the incudo-stapedial articulation cannot be brought into view; we must then pass the angular knife used for this purpose backwards through the opening in the drum-head, the blade in a horizontal position, until it impinges against the descending arm

[1] Method of J. Simrock, Med. Record, Mar. 27th, 1875.

of the incus. It is then turned up perpendicularly and passed about a line or less further inward, and beyond this bone, then turned back again to its first position. If now gently withdrawn, the blade will be arrested by the long arm of the incus, when, by cutting downwards, disarticulation is accomplished.

The author has found that the chorda tympani nerve is usually not disturbed by this operation, especially when the incus is first removed. If, however, it happens to be drawn down into view, a section of it may be removed, the resulting disturbance in taste being of short duration.

Where the incus cannot readily be found, protracted search should be avoided, since its retention could not be so productive of harm as rude attempts at removal; experience, moreover, shows that removal of the incus is not necessary to a favorable result of the operation.

The drum should be carefully cleaned with absorbent cotton after the operation. There is but little, if any, pain experienced by the patient on coming out of the narcosis, and a drop of a four-per-cent solution of cocaine put into the drum is sufficient to allay any discomfort. The free use of this drug is to be avoided, since a few drops may give rise to vertigo, nausea, and collapse. Syringing is not advisable, but the canal should be closed, after drying, with a pellet of cotton-wool.

It seems almost unnecessary to practise antiseptic precautions in this operation, where air enters the parts both from without and through the Eustachian tube; yet suppuration is very slight in most cases and in many does not occur at all.

In five or six days, any tissues left partly detached during the operation become necrotic and are discharged; the quantity is very small, usually consisting of shreds of the drum-head.

Chiselling away a portion of the sulcus tympanicus is quite unnecessary; indeed, the procedure is, from the irritation caused, likely to favor reproductive action.

The following cases of the author's are examples of this operation:

CASE 30.[1]—Female, 27 years of age, had been suffering from deafness in the right ear for some two years past, accompanied by tinnitus. The operation, undertaken on November 11th, 1886, (ether), consisted in making a large opening with sulphuric acid in the posterior segment of the right drum-head, and dividing the incudo-stapedial joint. To prevent reunion of the latter, the detached end of the long process of the incus was amputated. The parts healed up quickly, leaving a large opening in the drum-head through which the lower end of the long arm of the incus and the stapes could now be

[1] Cases 30, 31, 35 were exhibited in the December meeting of the Practitioners' Society of New York, 1887. See N. Y. Medical Record, Dec. 31st, 1887.

plainly seen. The patient could previously hear shouting only in the right ear at twenty feet as noise; she can hear now ordinary voice beyond twenty feet. There is a general improvement in the health of the patient, and the tinnitus ceased immediately after the operation.

CASE 31.—Male, 17 years of age, had been deaf since infancy. Operation under ether, February 16th, 1887. The entire left drum-head and the malleus were removed, and the incus was separated from the stapes. The parts were two months in healing, since there was a strong tendency to reproduction, and the newly developed tissues were removed, frequently as soon as formed. The result of the operation was as follows. Before excision he heard ordinary conversation at one foot from either ear, but worse in the left; very loud voice at four feet in both ears. Watch heard in both $\frac{0}{60}$. After the operation, ordinary voice heard at five feet, loud at twenty feet; watch $\frac{4}{60}$. Patient relies now entirely on the left ear, the right having become gradually worse.

CASE 32.—Female, 24 years of age, had been deaf since childhood in both ears. Patient is mentally a dull and stupid person. Many carious teeth. General catarrhal condition of naso-pharynx. Operation, June 23d, 1887. Ether. Left ear. Whole of drum-head and malleus excised. Incus not removed. There was some slight amount of reaction in this case, which, however, caused very little trouble to the patient. No reproduction of drum-head. The improvement in hearing was considerable. Before the operation, she heard in the left ear only loud voice at two feet, shouting at six feet distance. After excision, she could hear ordinary conversation voice very well at three feet and fairly well at six feet. Owing to the patient's neglect and exposure, also the constant reflected irritation in the ear from the teeth, a good deal of the improvement was subsequently lost. She hears now ordinary voice at two feet and loud at ten feet.

CASE 33.—Male, 40 years of age, a sailor by occupation, had been suffering from deafness for some years, in both ears, but had noticed this during the past six months more especially; much tinnitus. Many bad teeth. Chronic pharyngitis. Patient is practically stone deaf in the left ear; can hear loud voice in the right (after Politzer) at twenty feet distance. Operation, July 7th, 1887. Ether. Excision of entire left drum-head, malleus, and incus. Hemorrhage slight. Reaction very slight. Some little mucous discharge followed, lasting but a few days. Hearing in left ear impoved to plain ordinary voice at two feet distance, after excision. Reproduction of the drum-head began ten days after operation and was complete by August 1st. Patient then went to sea, passing from under observation. He thought (when last seen) that his hearing was better than before the operation, but this is not proven by an examination of his hearing power.

CASE 34.—Female, 22½ years of age, had been afflicted with deafness in both ears for the past five or six years. Is subject to colds in the head, headache, dizziness, tinnitus aurium. Irregular menses.

She is rather neuropathic, run-down in general health, although her appearance is that of a pretty healthy person. Has chronic pharyngitis. Two days before the operation, an application of acid. sulph. was made to the drum-head of right ear, and on an opening being produced, the hearing in that ear improved to low ordinary voice at four feet distance. Before she could not hear even shouting in this ear at the same distance.

Operation, August 1st, 1887. Ether. Excision of right drum-head, malleus, and incus. Reactive inflammation which followed was slight. On August 3d, patient could hear low voice at five feet, ordinary voice at ten feet, and loud voice at twenty feet distance, in the operated ear. August 25th, ordinary voice heard at fifteen feet in right ear. September 2d, sermon at church easily understood. Low voice heard at ten feet distance. The discharge, following operation, ceased in three weeks. Partial regeneration of drum-head followed, but then ceased, leaving a large irregular opening which did not close. Condition of patient, who lives in the West, was the same when heard from several months later.

CASE 35.—Female, 32 years of age. There had been a gradual loss of hearing power, on account of chronic catarrhal inflammation, for the past three years, especially in the right ear. Patient was obliged to give up several situations on account of this. Hearing in right ear: ordinary voice at ten inches, loud voice at five feet, and very loud voice at fifteen feet.

Operation, November 10th, 1887. Ether. Drum-head and malleus of right ear excised. Incus not removed. Slight local reaction. No pain; only a slight serous discharge, and a diminution of the sense of taste on the right side of tongue for a few days. Parts healed rapidly, leaving a free opening into the drum. Hearing after the operation in right ear: ordinary voice at five feet; also at ten and twenty feet, but less accurately. The opening into the drum closed in January, 1888, the patient experiencing no loss of hearing. The former opening is closed by a manometric membrane which moves correspondingly on expiration and inspiration, and is so thin that it gives way on slight pressure with a probe.

CASE 36.—Male, 42 years of age, had been troubled with deafness since the age of thirteen years, after an attack of typhoid fever. Since the age of twenty-two, he cannot hear ordinary conversation at all. Hearing: ordinary words heard on contact in both ears. Operation, January 4th, 1888. Ether. Excision of right drum-head and malleus. Incus not removed. No reaction. The day after, street noises, rattling of dishes, etc., were heard for the first time in many years, and very painfully too. Could hear now ordinary voice at three feet, loud voice at ten feet.

There is no tendency to reproduction.

In a number of other operations the result has been similar to the above, but they are still under observation at the date of the present writing.

CASE 37.—Seven years ago, this lady, 33 years of years, began to experience very decided deafness, commencing in the left ear. She was referred to the writer by Professor Austin Flint, who previously had found it advisable to send her to the mountains on account of her run-down condition. Whilst out of town, a severe head cold was followed by much deafness in both ears, from which recovery was never complete.

Examination showed both drum-heads to be largely cicatricial and of defective development. The first-named condition was due to severe suppurative inflammation in infancy, following scarlet fever. No improvement occurring in the deafness; the patient desired to be operated for excision. This was done on the right ear, January 12th, 1888, under ether narcosis, the drum-head and malleus being removed.

Some suppurative action following the operation, the parts healed slowly, leaving at the end of two months a free opening of triangular shape in the anterior aspect of the redeveloped membrane. The noises, which had been annoying before, disappeared entirely. Hearing before the operation in right ear, very loud voice only at five and ten feet. Hearing, since recovery, ordinary voice five at feet; moderately loud voice at twenty feet. Hearing for high-pitched sounds of all kinds increased in even a greater degree than for voice.

These tests, however, by no means convey an idea of the value placed upon the improvement experienced by the patient in the converse of every-day life.

As a result of exposure during very inclement winter weather, decided suppuration came on in three cases, and in two of these there was otitis externa lasting for several days. Where suppuration was thus excessive, reproduction was, seemingly, prevented. Extreme care was exercised, however, in all instances to prevent suppuration, and irritation of the parts in any way; some cases were not even wiped out, the slight discharge being allowed to become inspissated. Where crusts were thus formed on the inner end of the canal and over the margin of the remaining rim of the drum-head, the fundus gave the appearance of having been closed in by reproduction. On finally detaching these crusts, however, a large opening remained.

After healing has taken place, the mucous membrane undergoes dermoid transformation, its sensitive mucous surface having disappeared.

The operation was more successful as regards maintaining an opening in the drum-head in persons of slight build, and who were not given to the use of stimulants and the consumption of a large amount of meat. The existence of advanced atrophic inflammation was, perhaps, more favorable to good results than the hypertrophic variety, or

when chronic (catarrhal) processes were still active, though improvement, as to hearing alone, was decided in these latter cases.

The operation is, in the opinion of the author, one without danger, if ordinary precautions are observed. Now that we may afford permanent passage for sound where obstruction, in cases of sclerosis of the drum, prevents its entrance, a wide field for the improvement of hearing, in certain cases otherwise irremediable, is opened. When the proper precautions are observed and subsequent treatment, with due attention to the physical condition of the patient, conducted with care, the operation will be found as successful as any in the domain of surgery.

PART FOURTH.

MISCELLANEOUS ARTICLES.

CHAPTER XVIII.

The education of school children with defective hearing. Remarks on the extent of deafness in the schools. Deafness among school teachers.

THE EDUCATION OF SCHOOL CHILDREN WITH DEFECTIVE HEARING.

School children having aural defects may be divided into two classes, the partially deaf, and totally or almost totally deaf. Either one of these groups is susceptible of an important subdivision, which space will only permit of mention being made here, namely, the mentally feeble and the mentally sound. Education of the feeble-minded is, of course, much more difficult, whatever the degree of deafness may be.

The subject of special instruction for the deaf is scarcely less important than that of education itself, and the comparatively slight attention given it seems to justify its consideration here somewhat at length. Since the writer first discussed the subject in a brochure published by the Bureau of Education in 1881, several writers at home and abroad have taken the subject up, notably Weil,[1] of Stuttgart, who examined some four thousand five hundred school children with reference to their hearing power.

Causes of deafness among school children. The sense of hearing is impaired by so many causes to which children are exposed, many of them almost unavoidable, that it is unusual to meet with a child that has not experienced some aural disease. If we accept the statement as approximately correct, that of the entire population not more than five in every hundred possess unimpaired hearing, some idea at least can be formed of the prevalence of this defect in youth.

The causes of deafness among school children are similar to those affecting other youths; thus blows, frost bite, and eczema of the auricle are not uncommon. The presence of wax or foreign bodies in the external auditory canal frequently causes deafness. Boxing and pull-

[1] Archives of Otology, 1882.

ing the auricle as a means of corporal punishment often injures the drum-head, and gives rise to more or less permanent injury of the organ. Some affections are even more severe, attacking the deeper parts of the ear or even the brain, as the otitis media of scarlet fever, or cerebro-spinal meningitis which invades the inner ear or the auditory nerve. A large number of ear affections in children arise from nervous sympathy, where the entire mucous tract of the head usually becomes the seat of inflammation as well as the ear. To the reflected irritation arising from second dentition and the premature decay of teeth, and in the summer months to bathing in rivers and in the ocean, many aural troubles are due. Many of the ear affections of children are well known to leave permanent injury, and persistent offensive discharge is a common sequel.

Some of the symptoms of ear disease among children, though similar to those occurring in other subjects, are of special importance, since they prevent the scholar from directing his attention to study. The more important are autophonia, tinnitus aurium, "numbness," and the like.

The *autophonous voice* sounds so alarmingly to children that they frequently avoid speaking altogether; when silence is thus maintained, the child is called "dumb." It has been the writer's experience to have many patients of this kind brought to the infirmary by their parents, and it has not infrequently come out at the examination that such patients have been severely punished for supposed stupidity. This condition of the hearing organ is by no means of infrequent occurrence, and the teacher should consider its possible influence on a child's behavior before condemning it as perverse or wilfully disobedient.

Noises in the head are very confusing to children who experience them in some degree with almost every cold in the head, and they are almost inseparable from all kinds of aural affections; they manifest themselves in an infinite variety of phases, almost every patient describing his own experience differently; they are thus said to resemble ringing of bells, the roar of the sea or of the wind among the trees, the buzzing of insects, the escape of steam, etc. To some these noises seem so loud that rest cannot be obtained. Where long neglected discharge from the ear exists, the distress from tinnitus is often very great indeed.

The above by no means presents in their strongest light the troubles that children experience when the sense of hearing is perverted; it may, however, serve to show that they are subject to some very distressing symptoms without always being able to make their suffer-

ings known, such facts, in the writer's experience, only being elicited from the uninformed and apprehensive patient by the most painstaking examination.

DEFECTIVE SCHOOL HYGIENE.

That we have a faulty system of school hygiene no one familiar with the facts will deny; and the remark is equally true both as regards the construction of our public school houses and the personal care of school children.

When we are appealed to as humanitarians to provide hospital accommodations for the pauper class, no means are spared in the planning and erection of healthful buildings for their use, but when school houses are to be constructed—where both body and mind should be aided in development, prepared, one may say, to enter the struggle for "the survival of the fittest"—their erection is, it is to be feared, too often intrusted to the political contractor, whose knowledge in building is chiefly confined to "making it pay."

It is to be hoped, however, that time will correct these abuses, and in the mean while the best must be done with such buildings as have been given us. These are not, perhaps, so faulty but that better hygienic regulations could contribute very much to their comfort and healthfulness.

It will, however, be useless to devise plans for the heating and ventilation of school houses so long as negligence and apathy prevail on the part of those who have such matters in charge; these seem to regard the heating of apartments occupied by school children as contributing sufficiently to their personal well-being. It is, no doubt, honestly believed by many to be more important to maintain a certain established temperature in the school room than to protect the individual from injudicious exposures to draughts or to an undue elevation of temperature, as the case may be. There has been so much said about the ills that arise from breathing foul gas and dust, which are believed to poison the blood or irritate the air passages, and so little said about the dangers of draughts of air, that the latter are liable to be overlooked in the anxiety to avoid the evils attendant on the former. Too much care cannot be taken, obviously, to avoid the inhalation of deleterious matters, but certainly equal care should be exercised to guard against the injurious effects of overheating and air draughts to which pupils are so much exposed. It would be of much service in properly ventilating school rooms were open fireplaces in more general use, and it is to be hoped that architects will insist on the introduction of these in the future. Insufficiency of

clothing and exposure to inclement weather, especially if obliged to sit in wet garments, is a common experience among children of the poor, whose parents urge their attendance at school under these conditions, that they may be relieved of their care at home. Children, on the contrary, become very sensitive from wearing too much clothing, the neglect of out-door exercise, and confinement in overheated rooms. Overheated rooms are, moreover, if ventilation is attempted, dangerously draughty. Head catarrhs with aural complications are as frequent from these causes as from any before mentioned. Neglect of the physical condition of school children would seem not a less culpable oversight than a disregard of intellectual training.

Temperature of the school room. The temperature of the school room should be kept at about 68° or 70° Fahrenheit, as indicated by the thermometer; it should not be regulated by the sensitiveness of any individual, such a test being by no means reliable for this purpose. The necessity for the renewal of fresh air for ventilating purposes must be determined by the season of the year, the size of the room, and the number of pupils present; when the doors and windows are thrown open for this purpose, the children should be required to leave their seats and walk about in order to avoid any ill effects from draughts. Children should be protected, if possible, from exposure to currents of air after exercising; nor should they stand or sit while "cooling off," but move about quietly and resume any wraps that have been laid aside. The air of crowded halls or lecture rooms, especially when illuminating gas is used, soon becomes much vitiated, and, by depriving the system of its natural powers of resistance, favors the invasion of colds.

Some of the school-houses of cities are necessarily erected in the noisy districts, for they must be near to the homes of the pupils. The unremitting din of street noises is undoubtedly distracting, especially when the doors and windows have to be kept open; such sounds fatigue the mind, however familiar they may be. The discomfort from this cause should be considered in selecting the site for a building, and the construction of pavements which allow of the noiseless passage of vehicles in the immediate neighborhood would be advisable.

Whilst our system of school hygienics is by no means perfect, the home sanitation of children is also deplorably faulty; when these shall have been corrected, much physical suffering will be prevented and many of the complaints under consideration avoided.

For more particular information on this subject, the reader may

consult other chapters of this work in which the causes above mentioned, and others, are specially discussed.

CLASSIFICATION OF DEAF CHILDREN.

Acquired deafness.—Conditions favoring early deafness are not wanting; indeed causation may antedate or be encountered at birth, since at this period the drum in a normal state contains no air, but is filled with loose œdematous connective tissue, which slowly disappears when aëration of the cavity takes place with the establishment of the respiratory act, the cries, and the performance of deglutition by the infant. When action of the upper respiratory tract is defective, as it may thus be at birth, or, soon after, by head catarrh or by aural catarrh, the necessary aërial equilibrium is not established, and oscillations of the transmitting apparatus cannot take place. Under these circumstances, the perceptive function lies dormant because it cannot be aroused to normal action.

Congenital deafness.—A tendency to propagate constitutional dyscrasias doubtlessly exists in some persons, and when predisponents to catarrh are active in such a case, hereditary catarrh may give rise to disease of the ear at the earliest period of life.

Deafness due to congenital anomalies of the auditory apparatus.—These are supposed to be traceable to some perversion of development during the morphological state. The hearing organ in man has both an intracranial and extracranial origin, one centric and the other peripheric. From the auditory vesicle which constitutes the centric is evolved the nervous or perceptive tract of the ear, while the first visceral cleft evolves the peripheric or outer structures comprising the transmitting apparatus, namely, the Eustachian tube, the drum, and the external auditory canal and auricle. Now during the embryonic or fetal states, any interference with the development in either of these regions would produce defects in the hearing organ. Evidence of developmental defects is not always obtainable, and where the trouble is centric the diagnosis cannot be made in the very young, for obvious reasons. Evidences of peripheric defects, however, are by no means rare; these consist, for the most part, in either defective or excessive development in the closure of the first branchial cleft, the most common form of which is *fistula auris congenita*. The presence of these anomalies is very likely to be overlooked. In the following typical example they were not observed until several examinations of the ear had been made, their existence not being suspected at first: The case was that of a child of eight years of age. She was thought to be defective in in-

telligence until she was two years of age, since she did not learn to talk; but she grew more intelligent in appearance, and it was then found that she was deaf. When four years old, some person undertook the task of instructing her during a long sea voyage, and she learned to spell and pronounce a few words. When five years old she was sent to the public schools in New York, and had made considerable progress up to the time when she was brought to the author. Examination of the hearing showed that she could not understand conversation in any tone at the distance of a few feet; but when her name was spoken in a sharp tone she would promptly look at the speaker. She can hear the voice quite distinctly when the speaker is only a few inches distant. The teacher, for some reason, requires her to sit in the farthest seat from her desk. A minute fistulous opening is to be seen on the front part of both auricles, from which a small quantity of offensive fluid issues spontaneously at times, and usually on the right side, when the parts are pressed by the fingers. The external auditory canals are of the normal size, but the drum-heads are somewhat defective in appearance, the membranes being puckered in their anterior superior quadrant.

The author has seen a very considerable number of these cases in adults, where hearing was always defective, and although generally unilateral, it is probable that in nearly all cases some degree of defectiveness exists on both sides. It seems probable that, where centric malformation exists, co-existent mental defects are liable to obtain, and we should, therefore, expect to find imbecility as well as deafness.

The existence of deafness is not discovered even by discerning parents during the first few weeks of infancy, and what is frequently a mere suspicion in this regard at the sixth month may not become a painful reality before the child is expected to talk, and then the slowness of intellectual development may not be properly attributed to defective hearing. Partial, but disqualifying, deafness is thus liable to be overlooked until school education is attempted.

The detection of the very existence of hearing defects, it may be premised, is attended with difficulty, even by experts, during the earliest period of infancy, and even at the school age the exact degree of disqualification is not readily determined; it is with the view of affording some aid to parents and teachers in this regard that this is written. In order to enhance the practical value of the views advanced, the author availed himself of notes that have been taken during an extended experience in the examination and treatment of the aurally defective.

The 478 cases of children's deafness selected as illustrative, are from among children seen in private and infirmary practice, and they represent almost every variety of disqualifying deafness. The defective pupils among this number were brought from both hearing and deaf-mute schools. A considerable number of these constitute a class not properly provided for in either, being too deaf for hearing schools and yet not deaf enough to be taught as deaf-mutes; they were, therefore, found to be oscillating, shuttle-cock like, between the two, liable to be cast forth into life with much less education than their intelligence entitled them to receive—usually with scarcely intelligible articulate speech.

On account of their instructiveness, there have been included in the cases above selected a few no longer strictly of the school age.

The cases may be divided into two groups based on their school status; thus 371 were attempting to retain their position in hearing schools, whilst the others were either so deaf as to be excluded or were not of the school age.

The first group of 371 was constituted as follows: 74 were between five and eight years of age; 200 were between eight and thirteen years of age; 97 were over thirteen years old. As to sex, 199 were females and 172 were males.

The causation in these cases could be traced, in the majority of the patients, to either purulent or non-purulent inflammation of the middle ear. In 219 of them it was the former, in 124 the latter.

Usually both ears were similarly affected in each case, but where a purulent affection existed on one side and non-purulent on the other, the case was classed with the former. In the non-purulent cases, both ears were almost without exception similarly affected, although the left ear was usually the worse of the two.

Belonging to either one or the other of the above varieties were 10 cases where the ear had been severely boxed or pulled, causing rupture or strain of the drum-head, and consequent deafness; 33 cases where cold sea-water had passed from the mouth up into the drum through the Eustachian tube, while the child was bathing in the ocean; 3 where water was introduced into the drum while sniffing it up into the nose, or in using the nasal douche. In 31 cases the cause was attributed to scarlet fever, in 17 to measles, in 5 to diphtheria, in 4 to whooping-cough, in 1 to mumps, and in 1 to syphilis.

The external auditory canal was obstructed in a number of instances, thus interfering with the entrance of sound; in 52 cases it was by wax, in 7 by foreign bodies, in 25 by narrowing of its walls by

inflammation. Among the last-named were 8 cases where the canal was ulcerated.

The drum-head gave evidence of defectiveness of the transmitting mechanism in a considerable number of cases. Thus, in 30 there was deformity of the membrana tympani from arrested development; in 27 cases there was greater or less destruction of the transmitting mechanism from suppurative inflammation; a polypoid growth sprung from the morbid tissues within the drum in 14 cases, and the inflammation extended from the drum to the pneumatic cells of the mastoid in 8 cases.

It is noteworthy that defective teeth were present in nearly every case, and in 189 of them the teeth were specially bad. Head-catarrh and enlarged tonsils were present in the greater number, and in 13 cases either the nasal passages were so much obstructed, or the teeth so malformed, that mouth breathing was habitual.

The affections thus far mentioned are those which interfere with the passage of sound to the middle ear and its transmission to the inner ear, but the deeper parts containing the distribution of the auditory nerve may, in the more severe cases of ear-disease occurring from scarlet fever, diphtheria, etc., be attacked at the same time. In 28 of these cases, it may be incidentally stated, either tumors, or abscesses, or wounds of the auricle from piercing for rings, were observed. Distress from the autophonia of ear-disease, the autophonous perception of voice and sounds arising from the performance of physiological functions of the circulation, respiration, and swallowing, were present in 41 cases, and dysacousma was present in 1. Otalgia was experienced by 28, neuralgia about the ear by 36, ear-cough by 10, epilepsy by 1, vertiginous symptoms by 18, chorea by 2, and various other reflex phenomena by 17.

In respect to the degrees of deafness, 113 were almost totally deaf, while the remaining 258 were all of them incapacitated in some degree from receiving instruction at school along with good-hearing scholars. Thus, some of them had to leave school entirely; some had offensive discharges from the ear or severe pains in the organ. Many of them, besides being backward from inability to hear the teacher, labored under the disadvantage of being regarded as "stupid," and were punished for inattention. In a considerable number, this punishment was the more reprehensible because of the almost total deafness which the teachers had taken no measures to discover, but had placed them upon back seats where they could hear nothing, and were punished accordingly.

Of the second group, consisting of 107 cases, 91 were so-called

deaf-mutes, and of these the ages and sex were as follows: 47 were males, 44 females; 45 were under five years of age; 26 between five and eight years; 13 between eight and thirteen years; whilst 7 were over thirteen years of age.

The 16 remaining cases composing the second group were such as were suffering from defective articulation, speech, mental development, etc., consequent, for the most part, to defective hearing. Eight of these patients were males, and 8 females. Six of the males and 4 of the females were over nineteen years of age, the remainder being children under ten years.

It was observed that in the greater number of all of the cases above presented, the cause of aural defectiveness was attributable to some inflammatory affection of the hearing organ. Changes due to chronic catarrh of the middle ear were observed in very many, as also were those consequent to chronic purulent otitis media. Marked arrest of development, as shown by the appearance of the drum-head, was present in numerous instances. In 4 cases the deafness was asserted to be of hereditary origin, and two children (deaf-mutes) were suffering from the effects of congenital syphilis. Whooping-cough was said to have caused the aural disease in 2 cases, diphtheria in 3, measles in 2, scarlet fever in 8, and typhoid fever in 2 cases. Cerebral meningitis, occurring in connection with children's diseases, contributed largely to the list of alleged causative influences. Meningeal inflammation is usually meant when pachymeningitis, cerebro-spinal meningitis, brain fever, cerebral meningitis, convulsions, fits, and the like, are mentioned by writers in this connection. It is impossible, however, to accept the assertion of the parents or of the patients themselves, in regard to the cause of their malady, in every instance, and this is especially applicable to the last-mentioned disease. Sometimes the symptoms of irritation of the stomach are so marked in meningitis that the case has been erroneously regarded as one of "gastric fever." On the other hand, it is not by any means uncommon to mistake an attack of acute inflammation of the middle ear for one of so-called "brain fever." In some of the cases above enumerated, especially among the deaf-mutes, the deafness was claimed to be congenital. Experience, and a more particular study of the subject, will often show that, in quite a number of these supposed deaf-born children, the disability should be assigned to extra-uterine causation.

Thus cerebral meningitis affecting the nerve of hearing, and suppurative inflammation of the drum of the ear affecting the transmitting mechanism, consecutive to children's diseases, as scarlet

fever, measles, and diphtheria, are frequently met with at the period in life when children are learning to talk, and the more carefully these patients are examined in this regard, the more frequently will it be found that deafness was first discovered to exist subsequently to some attack of this kind. In eliciting from parents the history of these cases, one should not place too much value on alleged injury to the ears from falls and blows on the head, which are often advanced as causes.

In nearly all of these patients there existed catarrh of the upper air-passages, decayed teeth, etc.

In regard to their aural defectiveness, many of them were found to hear well enough to be taught *aurally* by the aid of a conversation-tube, or by using the voice close to the child's ear in teaching; two of them, although totally deaf, attended school along with hearing pupils; six of them retained speech after losing their hearing, and this without the aid of a teacher, and one of this number, a girl, continued to use the English cockney accent which she had acquired before becoming deaf; in nineteen cases the children were losing the speech they had acquired before becoming deaf, or were very defective in this regard from neglect to teach them. The younger children composing this last-mentioned class were nearly all of them backward in learning to talk; one of them did not acquire speech until his good-hearing brother became old enough to converse with him, and another did not talk until five years of age. In numerous instances the patients had never learned to talk, and a considerable number of these were considered mentally defective, solely on account of this defect, by their parents or teachers. In two cases it was noted that the impact of sounds was painful (dysacousma).

The defective children believed to be greatly neglected in regard to their education may, for convenience in this connection, be arranged into three classes, namely:

1. Children defective in one or both ears, and requiring close proximity and distinct utterance when taught. Of these, deafness in both ears requires seating on front row of benches, but when only one ear is affected, the normal ear must be toward the teacher's desk.

2. Children very deaf, who cannot distinguish ordinary conversation in either ear when more than a few inches from the speaker or unless the conversation tube, otacoustic fan, or other aid to hearing be employed.

3. The totally deaf, in whom the auditory apparatus of the middle ear cannot be made available. This class admits of division into two subdivisions, viz.: *a*, those having learned to talk previous to losing

their hearing, and *b*, those born too deaf to ever have naturally acquired speech, commonly known as congenital deaf-mutes.

The confusion and consequent injustice to deaf pupils arising from neglect to classify them properly. It will be admitted, if the figures above given concerning the deaf be approximately correct even, and it is believed as further examinations are made they will be found not to be in excess of the correct number, that, in so far as educational objects are concerned, we cannot separate pupils into two great classes, *one of which can hear well and the other not at all*, by an arbitrary or sudden line of demarcation, inasmuch as the hearing disabilities of children consist in all degrees of deafness, ranging between slight defects and absolute incapacity.

It would seem necessary, therefore, that some practical scheme for the classification of the deaf should be made which would not exclude any from the schools. Under the present arrangement, the only class of defectives provided for has been the so-called deaf-mute class, which leaves out of consideration entirely a large number of partially and very deaf pupils, occupying, so to speak, intermediate ground between totally deaf and normal hearing persons. This arrangement absolutely places a certain number of pupils in a worse condition than if entirely deprived of their hearing sense, and in consequence a great many of them find their way into deaf-mute schools. Thus it will be seen that the classification in both the day and deaf-mute schools is defective, and that in any attempt to improve matters we are at once met by a most complexing dilemma; thus, owing to the long continued practice of forcing all deaf pupils into either a totally deaf or good hearing class, we find that some of the former and all of the very deaf and partially deaf have been relegated to the hearing schools, while other very deaf persons are classified with the totally deaf and taught as deaf-mutes.

It will be well to define the different degrees of aural disability which incapacitate the pupil, to a greater or less extent, from receiving instruction in the ordinary manner, in order that it may be ascertained what special means of instruction are necessary.

Normal hearing may be said to consist in the mental perception of sound that has been transmitted through the unimpaired medium of both ears. Without binaural hearing the aquisition of knowledge by the ordinary methods of instruction becomes difficult proportionately to the degree of aural impairment. Hearing with both ears thus enables the pupil to quickly determine the direction from which sound proceeds, and it also enables him to promptly recognize the finer shading in the pronunciation of words. When, therefore, a pupil is ob-

served to be backward in his studies, the teacher should, before attributing his want of success to mental defects, inquire if he hears well. It would be by no means a wise procedure to classify every departure from the normal standard among those who require particular care on account of their defectiveness, for a pupil may progress very fairly in his studies when the hearing of only one ear remains or when he has very considerable defects in both ears; yet such pupils will be very much aided by the recognition of their disabilities.

The acquisition of language may be said to consist in correctly hearing the words and sentences of which language is composed, and in the persistent repetition of the same until memorized. Children, therefore, require good ears and long practice in the imitation of the voice of their instructors before they become masters of spoken language. It should be kept in mind here that a slight degree of deafness may be sufficient to hinder the child in the first steps that he takes in learning to talk—and these first steps are, probably, much more immature than they are usually thought to be, as the infant is at first, probably, unconscious of most sounds, the perceptive faculties of the ear not being taxed beyond the requirements of the mental faculties.

It is very difficult to discover defectiveness of hearing before the child is one year old; owing to this fact, the child may be "stone deaf" for a considerable time before the discovery is made. Even a slight defect in hearing is a detriment to the infant, for his education begins as soon as the slightest attention to sound is given.

The child, in this process of acquiring knowledge, repeats words as they are heard; if it hears them incorrectly, a faulty enunciation is acquired; thus every one has observed in his own experience how unintelligible the language of partially deaf children is, how slow they are in learning to talk. The flexibility of the voice is naturally very great, and uninterrupted practice increases its fluency from day to day; the young learner, relying on his imitative faculties rather than his own judgment, readily adopts the accent of his teachers and associates, and in this manner he acquires the dialect of the locality in which he lives.

The hearing that remains after injury of the ear-drum. Often after great impairment or destruction of the transmitting apparatus of the ear-drums, a very efficient passage of sound to the auditory nerve remains; but as this becomes more and more difficult, it deteriorates in quality, especially for long distances, until finally its rendition in the very hard-of-hearing becomes so crude and indefinite that interpretation by the perceptive tract is difficult, or even impossible.

Now, when sound ceases to be transmitted in this manner, hearing may take place by means of the passage of sound up through the tissues of the head to the perceptive tract as propagated by means of the otacoustic fan placed on the teeth, or the conversation tube placed in the mouth. In the former instance, sound passes more directly along bone structure from the teeth, while in the latter it ascends to the vault of the resonating chamber at the top of the pharynx and thence up through the tissues of the head. Voice-sounds imparted to a pupil in the manner just mentioned are of very great value in certain cases, because of their tones being natural, and the pupil's own voice is even more effective in this respect, since it is propagated upward with much energy by his own vocal efforts against the moist and highly receptive pharyngeal vault.

Incapacitating deafness. All degrees of deafness may be said to impair the learning capacity of a pupil, but in establishing a standard of impairment which shall consign a pupil to exclusion from his better hearing fellows for instruction, it would be well to select for special methods those who are unable to understand what is said to them in the ordinary tone of voice when five feet away from the speaker. Such a rule, however, must necessarily be applied with discrimination; there must be, in other words, a flexible standard, for some defective, but well advanced, pupils, by reason of their natural quickness, will, without being a hindrance, do much better when subjected to the emulative influences of good hearing children.

THE TREATMENT, MANAGEMENT, AND EDUCATION OF DEAF PUPILS.

The question of the accountability of the public schools for the physical as well as intellectual improvement of children is, to some extent, a debatable one; it is a matter that seems to depend, in many instances, on the sense of duty that inspires the management of particular schools, inasmuch as the recommendations for the guidance of teachers concerning hygienics are entirely inadequate. The writer believes that, as regards the more unfortunate children of the very poor—the unwashed of both body and raiment—no inconsiderable number of them would be more benefited by personal hygiene than by mental training; at least the two should go hand in hand in every instance, for *mens sana in corpore sano*.

The chief object of the public school system being the elevation of the entire population, thus placing them beyond the boundary of charitable support, their bodily well-being must be assured by influences brought to bear during the formative period of life.

In their examinations, deaf children, notwithstanding their defects,

may come forward well prepared; but if examined in a hasty or impatient manner, the teacher's questions are liable not to be heard well enough to elicit correct answers, and they are thus unable to secure a promotion which their preparation has justly entitled them to receive.

The surroundings of these children are in every way discouraging; they are disheartened both at home and at school, subjected, as they are, to the jeers, ridicule, and mockery of their companions, and to the punishment of parents and teachers for seeming inattention and dulness.

Their inability to hear much of what is said to them, the difficulty they experience in the correct pronunciation of words when the vocal organs are deficient, and the dismay occasioned by autophonous hearing and noises in the head, either singly or combined, are sufficient to entirely discourage these sufferers. That they become distrustful, deceitful, and vicious in character is to be expected.

When we come to consider what effect these various experiences must have on the minds of children, our sympathies should be enlisted in their behalf to the last degree, and our patience should be without limit; in a word, when no apparent cause for a child's dulness of action is known to exist, let there be made a thorough investigation into the condition of the acoustic organs before necessarily regarding it as a dunce or feeble-minded.

In the treatment or education of deaf children, it is well to keep in mind the fact that defectiveness is not always absolute, and may, therefore, be amenable to treatment on the one hand, while not constituting an insuperable barrier to aural instruction on the other.

It would seem that the neglect of deaf-born children, in the lower order of social life, much more frequently results in dumbness than would occur if more pains were taken in their education; indeed, where the offspring of deaf-mutes are constantly surrounded by deaf-mutes, holding converse with each other by signs only, it would be strange if they should learn to talk unless possessed of good hearing and allowed to associate with speaking persons. If children with defective hearing organs have but little, if any, opportunity to employ them, it is probable that continuous disuse of the sensory tract would finally lead to its deterioration. A child brought up under favorable conditions in this respect would acquire the use of the voice with difficulty, if at all, since even where normal hearing exists and favorable opportunities are afforded for learning, it is only after long and patient practice that intelligible speech is acquired.

The examination of pupils in the public schools with a view of de-

termining their hearing power. It will not be denied that these disabilities among pupils should be known to teachers in order that instruction may be made more successful, and it therefore becomes important to adopt some plan for correctly determining the hearing power of all school children, so that where any defect exists pupils may be placed under the best possible advantages. While teachers are known to often fail to discern marked departures from the normal standard, and children themselves cannot always give reliable information, yet much could be accomplished by principals and teachers were they assisted at the start by an expert in such matters, especially so far as the majority of pupils are concerned; but where it becomes important to ascertain the exact state of the transmitting apparatus of the ear, and the condition of the nerve-tract connected with audition, an expert examination would be required.

It would be well were it a requirement that the pupils of the public schools should be examined at the beginning of each session with a view to ascertain what number were too deaf to receive instruction in the ordinary manner and what number, having slight defects, would get on better if seated properly in the school room.

Method of testing the hearing power of pupils. In conducting examinations, it will be found that the voice of the person with which the children are familiar in learning, is the best test, and, indeed, it is the only sound [1] that need be used; sounds like the ticking of a watch, for example, need not be employed, as the ability to hear them is not significant as regards the pupil's hearing power for sounds used in teaching.[2]

The sentences selected for tests should be intelligible to the understanding of the pupils, and yet not altogether familiar ones, such as "What's your name?" and the like, and some of the words ought to contain the hissing sounds, others the guttural, as "m," "n," "g," as these are heard with the greatest difficulty. Unless the sentences made use of are frequently changed, the pupils may become familiar with some of them and thus comprehend their import without hearing them distinctly.

[1] The audiometer arranged by Prof. Graham Bell, may be found useful where more delicate tests are required, and its introduction will very much facilitate the work of classification when used by an intelligent and trained examiner.

[2] The difficulties in the way of establishing a uniform standard for the voice test are well-nigh insurmountable, inasmuch as no two persons possess voices of equal quality; it is thought best, therefore, for the teacher of each class to examine his own pupils, employing for this purpose the tone of voice usual in teaching.

During the examination the pupil should be placed about twelve feet from the examiner and should close his eyes to prevent lip reading; an assistant may then stop one of the pupil's ears by the pressure of his finger while the other is being tested. The examiner can now ascertain the hearing power by raising or lowering his voice as required.

In every instance where the sense of hearing is found to be defective, some record of the fact would be found serviceable for future use. It may be well to remark in this connection that the acoustic qualities of the room in which an examination is held should be taken into account—whether it be a large or a small room, whether containing many persons, draperies, etc., or comparatively empty, and, finally, whether any open doors or windows admit sounds from without. The age and the mental development of the pupil are also factors of importance, an uncultivated mind being slow in comprehension.

The *separate education* of pupils whose impaired sense of hearing debars them from the benefits of education by ordinary methods, from the investigation that has been made concerning their capacity to acquire knowledge, would seem to be a necessity. The claims of the deaf-mute have been long since recognized, and his wants in great measure provided for; it remains now to recommend measures for a neglected class of equal numbers, whose requirements are no less urgent.

The writer will not, in this connection, essay to suggest any matured scheme for the special instruction of those who are not entirely beyond the reach of vocal methods, but who are yet too deaf to be taught with good hearing pupils, without interfering with their instruction; the attempt would carry him beyond the scope of this chapter. Such a scheme will require for its successful development the time and labor of experienced teachers, and even under the most favorable circumstances the progress of any plan will necessarily be slow. The author will, however, venture to offer some suggestions in the matter, hoping that, inasmuch as his views have been derived from a very considerable experience in the observation of aural defects, the advice given from an otologist's standpoint may not be without value.

Disposition of deaf pupils in the school-room. Any pupil found to hear the ordinary voice of the teacher with difficulty should occupy a seat near him.

When hearing is good in one ear only, the child will hear to the

best advantage if seated rather to one side, so that the good ear will be toward the teacher.

Pupils whose defective sense of hearing prevents them from receiving scarcely any instruction by the usual vocal method should be, if possible, separated from the good hearing, and taught by special methods. As intimated before, children who cannot understand the teacher at the distance of five feet, when addressed in the ordinary tone of voice, are not only an obstruction to the work of teaching other pupils, but they can learn but little themselves. These pupils, in many instances, may perhaps remain very deaf only a short time; they may be entirely cured by treatment; special instruction would then, in these cases, be regarded as tentative only, for when improvement takes place their advancement will be more rapid among pupils whose hearing is good.

When it is found that children are too deaf to make any progress or, from an increase of deafness, it is unmistakably manifest that they cannot be instructed by vocal methods, they may be relegated to a department where deaf-mutes alone are taught.

It is, of course, important to discover the existence of mentally feeble scholars since these are often incapable of making scarcely any advance, besides being a hindrance to others.

The importance of early training for deaf children.—Too much stress can scarcely be laid on the value of results obtainable in this way if early made, since the perceptive power may be much quickened by training in many instances, even where the middle ear apparatus is defective. It would appear to be on the development of the perceptive tract, rather than on any change in the transmitting mechanism, that mental improvement depends in the very deaf who are taught aurally. The expert himself finds it no easy task to get at the facts in certain cases, especially in young children who have already been instructed as totally deaf, since they soon come to disregard the hearing sense entirely, and it remains to be determined in such cases how much the auditory nerve has deteriorated from disuse. The professed indifference to hearing should never prevent some attempts being made at instruction through the hearing organs, since a surprising amount of hearing may thus be found to exist. How many children one meets with who are backward in learning to talk, but finally, on getting to be three or four years old, gain their speech! Such children would get on much faster in many instances, it is believed, if regarded as partially deaf. While treating such children professionally, the writer has seen beneficial results from the use of conversation-tubes, or the employment of voice at close range. This practice can-

not be too early commenced. Good results have been recorded in children as young as eighteen months. In observing these cases, one cannot but be impressed with the importance of normal hearing in the ready acquirement of speech, and that, however imperfect the hearing may be, it has its uses in acquiring language.

If a medical writer might venture to offer a suggestion in pedagogics, the author would urge early attention to home instruction for deaf children. Hearing children naturally pick up their earlier education without effort from parents or by themselves, but deaf children must be unremittingly taught at close range; words must be uttered directly into the ear, not loudly, but distinctly. Tubes are of value in conducting sound to the child's ear where close contact of the mouth is inconvenient, and the child should be encouraged to repeat its own words through the tube to its ears so as to compare its own voice with the instructor's. If this course be pursued early enough, the writer is convinced that but few children would be found without *any* hearing sense, and many who have considerable hearing likely to be lost from disuse, would gradually be improved.

The greatest difficulty encountered at first is in overcoming inattention on the part of deaf children, who are disposed to rely on the sense of vision, since it offers a so much easier method of conversing. Much time is, doubtlessly, lost, from neglect to insist on this matter.

The dumbness of deaf children by no means always bears a constant relation to their aural defectiveness; a child intellectually bright, with favorable opportunities for learning, will make much more rapid advances than a child mentally dull and neglected. The writer has met with numerous examples where totally deaf persons obtained an excellent education in private hearing schools; they had been, of course, attentive and quick to learn, and special attention had been given them by teachers.

Teachers of deaf pupils. Many teachers have already fitted themselves for this work, and it is a significant fact that the growing demand for better instruction of the deaf has enabled them to find ready employment either in families or in conducting small private day-schools, since parents are willing to incur this extra expense rather than place their children in deaf-mute institutions. Where this expense cannot be borne, and parents are unwilling to send their children away from home, it seems that to exclude them from the advantages of day-schools is to disregard their rights.

The classification of the future. No time should be lost in taking steps in this direction; a little classification must necessarily pave the way to improvement in the education of the deaf of every degree. It

should be kept in mind, however, that, in a certain proportion of the partially deaf, the defectiveness is transient and variable; and that in some of the more difficult cases among the very or totally deaf, repeated examination will have to be made when any doubt as to the diagnosis remains.

TOTAL OR ALMOST TOTAL DEAFNESS AMONG SCHOOL CHILDREN.

When the acoustic organs are too greatly impaired for aural instruction, pupils are generally designated as deaf-mutes. They are not all of them, however, mute, nor can they all be instructed equally well. It would be advisable, therefore, for the purposes of instruction, to divide this class of persons into two principal groups, as follows:

1. Those who have never learned to talk.
2. Those who have learned to talk before becoming deaf.

Of the first-named group it may be said that a certain number are congenitally defective, while others become deaf at a later period in childhood. Notwithstanding the profound deafness of these children to outward sounds, some of them are capable of learning to speak with greater or less distinctness, the perceptive functions of hearing having been preserved to a goodly extent, though the transmitting mechanism has sustained almost complete impairment. To the greater number of these pupils the autophonous voice, which remains to them, is very far from imparting a natural impression of the voice to the mind; their vocalization is notable for its "muted" cadence, the words seeming to be uttered in imitation of the sounds transmitted to the perverted sense of hearing from their own vocal organs. A much better vocal power remains when children have previously learned to talk well than when speech has not been so acquired. Under no circumstances, however, will the voice remain unchanged; it is no longer flexible and pleasantly modulated, but soon becomes mechanical and harsh.

The second group of deaf-mutes includes those in whom there is an entire absence of the perceptive function of hearing, either congenitally or from the more severe diseases which deprive the auditory nerve of its functions. In some of these the transmitting mechanism of the middle ear may not be greatly impaired, but the nerve no longer perceives sensations of sound from any source.

Of these, the congenitally deaf can never, the author is inclined to believe, practicably be taught to speak very intelligibly, for they cannot hear any sound upon which the mi ·m an idea as to the character of speech. They, howe fairly acquired

speech may retain the use of it in a very satisfactory degree after becoming deaf, if well trained. Very young children who have only just learned to talk soon lose the faculty, and it is very difficult for them to ever learn to speak well again.

In a certain number of cases of deaf-mutism, both the middle and inner ear are undoubtedly affected by disease, but in the greater number of cases the disability seems to be mainly seated in one of these regions only. Where the functions of the nerve of audition have not been exercised, in consequence of early impairment of the mechanism on which transmission of sound to the inner ear depends, its deterioration will probably ensue. Owing to the neglect of a great many of these children at home, the difficulties in the way of their education are much increased. Although the number of pupils who will be found to retain some sense of sound perception is comparatively small, yet it would be well to differentiate between these and the pupils who do not, for the former possess capabilities for learning which the latter do not enjoy; the one may acquire articulate speech, while the other may be advantageously taught the sign language only.

These children, in the larger cities, could in many instances be more economically taught if kept under home influences and educated in a special department of the public schools.

THE EDUCATION OF DEAF-MUTES AND THE VERY DEAF.

a. In the day-schools. While attention has thus been drawn to the wants of the partially deaf, strenuous efforts have been made in behalf of the deaf-mute with a view to improving his educational facilities. The labors of Professor Alexander Graham Bell in this field have been notable, and besides giving much personal attention to the work, his contributions to the literature of the subject have been numerous and valuable. But while the writer himself has mainly had in view the needs of the partially deaf, yet in pursuing this interesting subject from his own point of view, it is to be plainly seen that from a pedagogical standpoint a very considerable number of deaf-mutes, so-called, may be more advantageously provided for in the public day-schools than otherwise.

Day-schools for deaf-mutes have thus been established in the United States as follows: Horace Mann Day-school, Boston, in 1869; Erie Day-school, in 1874; Chicago Day-school, in 1875; Cincinnati Day-school, in 1875; Portland, Me., Day-school, in 1876; Rhode Island Day-school, in 1877; St. Louis Day-school, in 1878; Phonological School, Milwaukee, in 1878; Oral Branch Pennsylvania Institution, Philadelphia, in 1881; Scranton Oral School, in 1883; A. Gra-

ham Bell's School, Washington, D. C., 1883. It would seem that the systems of deaf-mute education were undergoing a transformation at the present time, since hearing defects are beginning to be regarded as constituting a factor of varying importance, no longer offering an insurmountable barrier, in a great number of instances, to an education which shall enable them to hold converse after the manner of hearing persons.

This leads to the opinion that very considerable numbers who are at present being educated as deaf-mutes could be cared for in the public day-schools along with the very deaf who are at present unprovided for, since they both require similar methods of instruction.

Totally and very deaf children, moreover, require taking in hand at a much earlier age than is feasible in deaf and dumb institutions; their education should, in fact, begin much earlier than it is commenced at present; they should be placed in school when four or five years old. Children who have lost their hearing soon after acquiring speech soon forget to talk unless means are promptly taken to keep them in practice. The same rule would apply with equal force to the congenitally deaf, since valuable time is lost when instruction is neglected during the impressionable period of early childhood. It becomes a necessity in respect to the education of children at such a tender age that they should be provided for in schools near their homes, an entirely practicable matter, fortunately, in large cities and towns, and even in sparsely populated districts, according to the reasoning of Bell in his "Memoir upon the Formation of a Deaf Variety of the Human Race."

As to disassociating very young children from home influences, the humane impulses of parents are altogether opposed to this; the writer has often witnessed the dismay and grief of parents when informed that their deaf children could obtain an education only in a deaf-and-dumb institution. There are, perhaps, a few families who prefer to place their children away from home, where the responsibilities of support and training will be assumed by others, but it is otherwise with the better class of our citizens, who desire to have them brought up more as other children.

b. In deaf-mute institutions. In certain institutions an increased interest has shown itself of late in respect to the very considerable number of pupils who have ›fore been treated as totally deaf, but who are, in point of fact, s of more or less perception of sound, which ma' 'n education. The results alleged to have ı ıral teaching are very

gratifying. During the year 1877, the writer visited some deaf-mute institutions with a view to discover what number of these pupils could hear the voice by means of a conversation-tube placed in the mouth or ear, and he was surprised to find a number being educated as deaf-mutes with whom conversation could be carried on orally by the employment of this aid to hearing. Repeated observations, subsequently made by teachers, have confirmed the above, and it is now believed that, of all the pupils in deaf and dumb institutions, a large number could be educated through the hearing sense by the aid of speaking-tubes and otacoustic fans, and that a small number hear well enough to be taught by the unaided voice. In the Minnesota institution it has been found that from fifteen to twenty-five per cent of all the pupils received can be taught by the aural method, and that after being instructed for a time many could hear well enough at the distance of ten or fifteen feet to converse when elevated voice was used.

The disadvantages arising in deaf-mute institutions from the want of classification show themselves in many ways; thus, where no useful perception of sound has ever been experienced by a pupil, as in most congenitally deaf persons, or where mental feebleness exists, there is very great inaptitude for the development of the perceptive function, and while efforts to arouse this dormant function must not be too early abandoned in doubtful cases, yet it is well to consider how much labor can be profitably devoted to the task of teaching such pupils to converse orally. The discouraging result in such cases has doubtlessly been the means of establishing a preference for teaching the sign language, since in overcrowded deaf-mute institutions this method has the advantage of being inexpensive—an important item where the corps of instructors is small. It has been estimated that about ten per cent of deaf-mute pupils belonging to this class cannot learn to speak intelligibly unless much more attention is given to their instruction than is practicable in any public school.

The mediocrity of results attained is further increased by the mental inertness of deaf-mute pupils either admitted when too old to adapt themselves successfully to study, or retained too long after reaching adolescence.

The duty of the State in respect to the education of the deaf. The opponents of the proposed reform for teaching these defectives in the public day-schools assert that the policy of the State is to exclude all who cannot be regarded as having *average* mental and physical qualifications; but no one has ventured to define this standard. Indeed, it would be difficult to do so; and were all of the *average* pupils

selected, what should be done with the remaining pupils? This question has thus far been only tentatively met by the attempt to separate all pupils into good hearing and totally deaf classes.

By many it is held that our public-school system has for its principal object the prevention of illiteracy among the poor, and, if this view be correct, it can scarcely be regarded as consistent on the part of the advocates of educating the average child only to oppose a scheme for the promotion of the interests of a needy but uninfluential class, while fostering expensive institutions for the free education of the better-to-do, and going so far even to expend large sums of money in giving *special* instruction in German, French, music, etc.

This was certainly never contemplated by those who founded the common-school system. Nor is it humane to leave the care of this defective class to the uncertainties of philanthropic aid. The State already has abundant facilities for the care of all the deaf-mutes who cannot be educated in connection with the day system of public schools, and inasmuch as these institutions will soon be overcrowded by the natural increase of this class, it would seem that facilities should be provided for them in the day-schools without delay. There are already 17,000 deaf and dumb persons of the school age in the United States, according to the census 1880, only 5,000 of whom were in institutions.

The expense of educating the deaf in day-schools as compared with their education in institutions. The question of reform in the education of the defective in hearing is to a certain extent a question of expense; that they must receive educational facilities will not be denied.

Let us consider the result in this regard of transferring to the day-schools what may be regarded as their legitimate share of work. The outlay by the State would probably be lessened, so far as the deaf-mutes are concerned, and, on the other hand, it would be slightly increased were proper methods introduced for the instruction of the very deaf and partially deaf.

At the present time it costs the State to support and instruct deaf-mutes in its seven asylums $250 per capita annually. It will thus be seen that were classes of ten formed in the public schools, which is probably a smaller number than in asylum classes, and a teacher secured at the rate of $800 per annum, there would be a saving of $170 per pupil. Where smaller classes of children were formed, as might be done in the country, the saving would be less. The writer has no exact figures upon which an estimate of the number of partially deaf can be based, but from the large number met with in

practice, believes this to be considerable. These, however, could be taught in classes of twenty, and the increased expense would not be great; such pupils are at present taught, if they attend school, in classes with hearing children, and the increased expense in reducing the size of classes to accommodate them may be easily computed.

There need be no expense for new buildings, the structures at present in use for school purposes being sufficient, since it is thought best not to separate one class from another entirely any more than the different grades are now taught apart. Some instruction would be common to all.

IMPERFECTIONS IN SPEECH.

These are no less vexatious than the disability arising from deafness, and, whilst often existing independently of aural disease, such defects usually co-exist. Their differentiation is important in the management of backward children, for the subject may otherwise be relegated to the class of feeble-minded youth.

The correct enunciation of words depends very much on a healthy condition of the upper vocal organs—the mouth, nose, and pharynx—and on the unobstructed passage of air through them during vocalization. Repeated attacks of head colds, resulting in nasal catarrh, enlargement of the tonsils, congenital defects of the palate, etc., together with irregularities of the teeth, are the principal etiological factors in the development of impediments that interfere with the physiological functions of these parts. A nasal tone of voice is an almost invariable characteristic of these impediments, but very often the obstructions in the throat or nose are so great as to give a "choked" expression to the voice. Enunciation then is difficult; for example, letters which require for their pronunciation the use of some of these parts, as "m" and "n," cannot be correctly enunciated. When defects in speech arise from disease in both the ear and throat, the pupil is placed at a very great disadvantage indeed as regards the learning of correct enunciation, he fails to hear certain words and on the other hand there are certain others which he is unable to enunciate. Thus, the hissing sound of the voice may not be heard at all; the pupil is therefore liable to leave it out of his speech entirely; for example, he will pronounce sir as "thir" and sausage as "thausig," and so on. Should the deafness be very great, the person will omit such sounds entirely, not that he is physically unable to make them, but he does not know how they sound. Sounds well heard become familiar and are soon learned, but slow hearing persons soon become fatigued with efforts at listening and naturally seem inattentive.

Stenographers who are becoming more deaf, begin to get confused; "and" sounds like "an" etc. Now, should the pupil possess obstructions in the nose and throat as well as defective hearing, instruction under existing methods will be difficult—in some instances well-nigh impossible.

The voice, it should be stated in this connection, becomes very much modified after the individual ceases to hear well; it loses its flexibility and can no longer be modulated.

Children suffering from autophony or false hearing are often greatly bothered, since this phenomenon may confound even the most intelligent person, so difficult is it to understand why the seemingly strange alteration in voice should occur, and though not attended with imperfect speech, may be considered here.

Autophony[1] occurs during the progress of most aural diseases. It consists in hearing one's own voice in the head; it sometimes amounts to simply this, but there is often heard a reverberation of the voice, or an "echo," as it is often styled, and it is then described by the sufferer as double hearing. When the patient thus hears his own voice, he fancies that others cannot hear him talk, for the voice seems to go up into the affected ear instead of going out of the mouth. The effort of talking becomes very tiresome to him, for no exertion, however great, is of any avail; the louder he tries to speak the more disagreeable his voice sounds in his own ear.

The autophonous voice sounds very strange to the patient; it is unlike his own voice; it seems as though another person, at a distance, were speaking. When the voice is thus heard false by the pupil, he is unable to regulate or control it, for, in many instances at least, at one moment it may sound quite naturally, as though in fact it came out of his mouth and went around to the ear as usual, while the next moment it seems to fail of utterancea ltogether and reaches the ear from within the head.

In false hearing, the voice usually appears to be hoarse, the patient often calling one's attention to this with the remark that he must have caught cold. Sometimes the voice, however, seems to the sufferer to be very high in pitch. When hearing it higher than it should be, the patient makes an unsuccessful effort to correct the fault by lowering his voice, often to a whisper; when it seems "hoarse" and low, the attempt to correct the apparent defect results in an unpleasantly loud

[1] The number of persons who (without aural disease) possess these peculiarities is comparatively few, as far as is known, but as attention is directed to these conditions, it is probable that the number will be found to be considerable.

voice. For further remarks on this subject the reader may consult Chapter XVI.

With the fancy that it has been deprived of the ability to speak, the voice failing of utterance, comes the conviction of "dumbness," and with the feeling comes the peculiar "dumb" expression. But this is by no means always the entire experience of the sufferer, for the voice, which has been said to seem to fail of utterance, seems to ascend into the head, where its unusual reverberations give rise to the belief that the head is "hollow" or "empty." These are alarming symptoms, and, inasmuch as they recur with every attempt at speech, the child fears to make an effort which is attended by such disagreeable symptoms.

Noises in the head are seldom absent when autophony exists. The character of the noise depends very much on the imagination of the patient, and may, therefore, be said to be variable; but it is also influenced greatly by changes in the transmitting mechanism. In the worst cases, the patient hears the rushing of a railway train in the head or the raging of a storm; these noises are attended by sounds of ringing bells, pattering hail or rain, etc. When the patient has an interval of relief, the noises are more bearable; they may then be likened to the gentle sighing of the wind among the trees, the play of the surf on the sandy beach, the singing of the tea kettle, the buzzing of insects, etc. Patients usually describe these noises as resembling some familiarly remembered sound; thus the distant roar of a waterfall occurs to one, or the pattering rain to another, whose memory goes back to the days when he slept just beneath the roof. But very often the imagination fails to aid in the description, and with children the difficulties in the way of finding out their feelings are almost insurmountable.

Whilst these symptoms are usually of brief duration in a large number of cases, some of them become permanent.

REMARKS ON THE EXTENT OF DEAFNESS IN THE SCHOOLS.

In considering the relations of all classes of deaf pupils with both the public day schools and deaf-mute schools from the physician's point of view, it is believed that the extent and importance of the subject may be more fully realized than in any other way, since where professional advice is required opportunity is allowed for thorough examination of the hearing organs, both as regards their physical condition and acoustic functions. A very considerable experience, including observations on a large number of specially interesting

cases among school children of the poorer class, seen in hospital practice, led the writer to believe that great injustice was being done in permitting children to struggle for an education under the disadvantages arising from deafness without the aid of methods which experience had shown to be advantageous in such cases; he therefore concluded to make some efforts in their behalf, and in 1877 the matter was brought to the notice of the Board of Education of New York.

The Board referred the matter to the Committee on Teachers, and in explaining the matter to them it was shown that some children continued on at school, for years even, while scarcely any hearing remained, while there were many others who heard very badly; that in disregarding this matter deaf children were placed at a serious disadvantage, and that the time wasted in futile attempts to instruct them was a hindrance to others. Instances of special injustice were cited where children, defective in hearing, had made great efforts both at school and at home to prepare themselves for promotion, only to be put back on examination, because the principal was not aware of the child's imperfection, and therefore had not given his questions distinctly enough to be heard. Other deaf children, from neglect to classify them, were seated too far away from the teacher's desk to hear his voice, and in consequence of inability to reply correctly were frequently punished for inattention and dulness. The rudeness often practised toward these unfortunate pupils by unthinking or unsympathetic teachers was discouraging, and some pupils in consequence had left school altogether.

It was not recommended at this time that the partially deaf should be entirely separated from the hearing pupils, yet it was advised that pupils should be always examined with regard to their hearing, and that those found to be defective should be given every possible advantage, both in respect to seating and to distinctness of voice in teaching, the very deaf should have some instruction apart from others, since they often could not understand words shouted into their ears. The writer did not expect that the long-established order of things could be rapidly changed, but it is believed that teachers have become more interested in the subject than before, and that instances of "inattention" and "stupidity" are less puzzling since their true character is recognized. Complaints are now less frequently made by pupils who come for treatment of neglect in this regard, and, indeed, teachers very often recommend that deaf children be brought to our clinics for relief. No special action, however, was taken at this time.

In the mean time the subject of deafness among school children attracted the attention of the Educational Department of the United States Government, and the matter being considered important enough to justify a special investigation of its causes, the writer was requested to prepare a paper on the subject, which was printed by the Bureau of Education for distribution in 1881.

In order to obtain accurate data upon which a report to the Commissioner of Education might be made, the writer concluded to institute some examinations of the pupils in the public and parochial schools of New York with the view of ascertaining the percentage of deafness and the state of aural hygiene among them.

Being aware of the fact that deafness existed in numerous cases where an examination only would convince the patient of the fact, the writer, in conducting the school examinations, first interrogated both the teachers and the pupils as to their own knowledge of any deafness; their replies and the subsequent lack of verification are significant. It should be stated that these examinations were made under circumstances unfavorable to the attainment of such results as would be required for an exact classification of pupils, for at the visitations the children were sometimes found at their recitations or when they were on the eve of dismissal. But the results, though obtained under difficulties, are thought not to be without value. For his general conclusions on this subject, however, the writer has relied on the thorough examinations made of individual cases which have been brought to him for treatment; in these the tests of the hearing power were made deliberately, and the statements of parents regarding the cases were also obtained.

Five hundred and seventy pupils were examined; they were distributed as follows:

In the colored public schools	261
In the Roman Catholic parochial schools	226
In the white public schools	83
	570

An analytical review of the details of these examinations as exhibited in the tables[1] shows, that of the five hundred and seventy pupils examined, the teachers were previously aware of the existence of one case of deafness only, while the pupils themselves were but

[1] The details of these examinations may be consulted in the tables appended at the end of Circular No. 5 (Bureau of Education), Washington, 1881.

little better informed, only nineteen of the number being aware of their aural defects. In his own examinations, which were by no means searching and in which the teachers usually gave the test questions with the intent of compelling the children to hear them, the writer detected seventy six cases, or about 13 per cent, of greatly diminished hearing in one or both ears.

Four hundred and eighty-seven of the entire number of pupils were asked if they had ever experienced *earaches;* one hundred and seventy-three of them, or out 36 per cent, recollected having had this symptom. Among the other children but few had any recollection of ever having had pains in the ears, probably because past pains are soon forgotten. In all of these instances where earache had been experienced it may be inferred that the aural affection that gave rise to them had also more or less permanently damaged the sense of hearing; but such defects would not be apparent unless more delicate tests were made.

Believing that the time had arrived when more advantageous action might be taken in New York, the Board of Education was again induced to take the matter into consideration in 1884, a communication on the subject from the writer having been referred to the Committee on "Course of Studies." The Committee met on November 12th, and on invitation the writer presented some typical cases of aural disabilities in children, and gave the results of his experience concerning deafness in the schools.

At the meeting of the Committee, December 17th, 1884, the following resolutions were adopted: 1. "That it is inexpedient to establish special schools or special classes in existing schools for the instruction of the partially deaf." 2. "That the City Superintendent be instructed to require class teachers to investigate and observe respecting physically imperfect capacities of sight and hearing among the pupils, and to assign seats and positions in class rooms to pupils so as to relieve, as far as may be, disability arising from such causes; and, further, that in examination of classes by the Assistant Superintendents, observation and report be made to the City Superintendent with reference to compliance with this requirement."

The following is an *estimate of the extent of aural disabilities in the United States.* Careful estimates have been made, indicating than no greater number than five per cent of the entire population have normal hearing, but this of course does not show the number of persons defective enough to exclude them from the benefits of the ordinary common-school curriculum. The tenth census computes that there are about thirty-four thousand deaf-mutes in the United

States, or one out of every one thousand five hundred. One-half of these are illiterate.

Estimate of the extent of aural disabilities in the schools of New York City. In 1884, nearly four thousand deaf-mutes resided in the State of New York, and over one thousand in this city. Of the latter, five hundred and seventy-five were in asylums. The number of totally deaf persons of the school age in this city, but outside of asylums, was stated to be one hundred and sixty-three; but the estimate is much too low, since the enumeration of the census-takers was very unreliable in respect to this class. Parents are slow to acknowledge their deaf-mute progeny, and often the census-takers make no efforts to get at the facts. The writer has met with a considerable number of these children who were not enumerated, and he doubts not that there are no less than five hundred of them in this city, of the school age, unprovided with educational facilities.

Before the census of 1880 was taken, the question of ascertaining the number of very deaf people was considered by the special agent, Mr. Wines, but the scheme was abandoned, as it was thought that any returns of this kind would be wholly unreliable unless obtained by the aid of expert examiners. It is, therefore, impossible to give a very close estimate of their number; but if one may form an opinion from experiences in practice, the number having more or less disqualifying aural defects may be put down at no less than ten per cent of the entire school population of New York City. Thus out of about one hundred and forty thousand pupils in attendance at the public schools in 1884, some fourteen thousand of them would be the better for classification in respect to seating and instruction at close range, or by means of some aid to hearing. These figures show that we have to deal with a vast number of defectives, in respect to hearing, and although this avenue to illiteracy, and consequently to pauperism, was not of much significance when the country was new, it surely demands our attention now, when vagrancy and kindred evils are attracting so much attention from the vastness of their proportions.

DEAFNESS AMONG TEACHERS.

It is not unfair to state that teachers do not enjoy greater immunity from impairments of the sense of hearing than others in the same social position; and, although a certain degree of deafness should not exclude a person otherwise competent from the pedagogical profession, yet it must be confessed that good hearing is very

essential to one who has so many experiences to try his temper, and who should be able to avoid doing an injustice to any pupil from a failure to hear everything that is said in his presence. Should an instructor himself be defective in his hearing sense, and yet be unaware of the fact, it would be easy for him to unjustly censure children for incompetency in the course of instruction or in examinations for promotion simply because their responses were not heard. The writer has known instances where teachers when suffering from temporary deafness were almost sure to hear certain words incorrectly, and were therefore obliged to ask pupils to repeat their replies over and over again before they could assure themselves of their correctness. Such experiences are a warning to those having irremediable defects.

Persons desirous of acquiring a pedagogical education at the public expense should be subjected to an aural examination before they are accepted; and in the appointment of teachers in the public schools the ability to hear well should be a requisite. If the examinations were always oral, the applicants being required to *hear* the questions, they would be more satisfactory than if otherwise conducted. The author has in mind an illustrative case which is of interest in this connection: A young woman nineteen years old had been, it was supposed, thoroughly prepared for teaching, but she gradually became so deaf that when, after graduation, she appeared before a Brooklyn board of examiners for appointment as a teacher in the public schools, she utterly failed. The questions were given out orally, and she was unable to answer them because of her inability to hear them correctly. The board of examiners, however, was not aware of her aural defect. Had the same attention been given in the case of this person to the condition of the ears that was devoted to her mental improvement, her success would probably have been assured.

CHAPTER XIX.

The Effect of High Atmospheric Pressure on the Ear in Tunnels, Caissons, etc. The Effect of Submarine Diving on the Ear. The Effect of Sudden Rarefaction of Air externally to the Drum.

THE EFFECT OF HIGH ATMOSPHERIC PRESSURE ON THE EAR IN TUNNELS, CAISSONS, ETC.

The effect of subjecting the ears to high atmospheric pressure differs, when gradually accomplished, from the sudden concussion of explosives, as by the blast of great guns or boxing the ear. The injuries under discussion mostly arise from going into submarine caissons, though submarine divers, as is mentioned elsewhere, often experience unpleasant aural symptoms from this cause. The writer has had frequent opportunity for studying the effect of undue atmospheric pressure on the ear since the construction of the Hudson River Tunnel was commenced, some seven or eight years ago, a number of the employés having come to his aural clinic at the New York Eye and Ear Infirmary, on account of the injury done to their ears. It is well known that the atmosphere in which we live has a pretty uniform pressure upon the body of about fifteen pounds to the square inch. Now, any decided variation from such tension is liable to give rise to discomfort, and this is just what takes place in submarine caissons, where the pressure is sometimes four or five times greater. Persons about to be subjected to the greatly increased aërial pressure of a caisson are prepared for it gradually by means of a so-called lock, or air-tight chamber, which they enter and occupy until enough compressed air is gradually forced in to enable them to pass on into the working-chamber, where pressure is maintained as in the lock, namely, twenty to forty pounds, or more, to the square inch. The practical information obtained by the writer on this subject from one who had worked in the Hudson River Tunnel for two years and eight months is of interest. The informant, an Irishman, had worked about one-half of the period above mentioned under a pressure of about twenty-six pounds to the square inch, but often under much

greater pressure. At the Jersey City terminus, where he was employed, more pressure was required in tunnelling than at the New York end. The atmosphere was always humid, and the workmen were obliged to stand, while freely perspiring, in more or less water, which everywhere was oozing in. He stated that his ears were never affected, nor were his son's, though the latter commenced to work in the caisson four years ago, at the age of fifteen years, and remains there up to the present time. He and his son are both of them healthy and sober. They have been well while working in the tunnel, neither of them ever having had the "bends." He relates that he could whistle under a pressure of twenty-four pounds—a difficult feat, it would seem, since possible to but few even under a pressure of twenty-two pounds.

It may be premised here that were healthy and sober men, free from pre-existing aural trouble, only employed, there would be much less suffering from ear, or, indeed, other disease among caisson-laborers. But, unfortunately, many improper subjects are permitted to enter into this branch of labor, only soon to be discharged with impaired health, and often irremediable ear disease. The importance of this subject, the writer believes, will justify the introduction here of several illustrative cases from among others which came under his observation:

One individual, aged thirty, asserted that on several occasions, after descending the shaft and going into the lock, he had attempted to remain while the condensed air was forced in, but each time the distress in his ears had prevented him, until finally he forced himself to go to work in the caisson while still enduring much distress. The effect of the great pressure proved most disastrous, for he was afterward laid up, for a long time, with purulent inflammation of both ears.

Another person, whose case was similar to the foregoing, stated that the distress on submitting to the increased pressure in the lock was so great that he was obliged to scream out from the pain in his ears, demanding repeatedly to be liberated, but the man in charge jeered him and he was forced to go to work. In consequence of the injury occurring to the ears, he had been prevented from performing any labor for a long time.

CASE 1.—Lawrence C——, aged 25, a bricklayer, came to the New York Eye and Ear Infirmary, March 4th, 1880. Patient began to work in the air chamber of the Hudson River Tunnel three days ago. Works eight hours daily. From the start there was, on first coming out of the compressed air, a sensation of "cracking air," or rapid

concussions like "bubbles of air exploding" in the ears, but mostly in the right one. While at work he is very deaf, and has tinnitus and vertigo, symptoms which have become worse daily. Examination showed the anterior superior quadrant of the right drum-head to be highly hyperæmic. The left external auditory canal was found to contain a large plug of inspissated wax, the impaction of which from the atmospheric pressure gave rise to the vertigo and tinnitus. His teeth are bad, and he is subject to head catarrh.

CASE 2.—Patrick C——, 31 years of age, came to the New York Eye and Ear Infirmary, April 28th, 1882, complaining of earache on the left side. Three weeks ago he had begun to work in the caisson of the Hudson River Tunnel, and, on account of the exposure, soon contracted a severe head cold, followed in about four days by acute purulent inflammation of the left ear. It began with severe pain in the ear, which lasted for three days, when a discharge set in, which continues. There is intermittent pain in the right ear. The division of workmen to which he belonged labored for eight hours and then rested for sixteen hours. He has frontal headache, and pain in swallowing.

Examination of ears: Left canal filled with pus. Tenderness over left mastoid process, extending down to its apex. The right drum-head is hyperæmic, and has a dusky look.

Hearing: Loud voice only in the left ear; ordinary voice in the right ear.

The patient's throat gives evidence of long-standing inflammation, the mucous membrane being thickened and vascular. The tonsils are enlarged and the teeth are very defective.

CASE 3.—Richard F——, 38 years of age, came to the infirmary, October 30th, 1882. Never had any aural disease before working in the caisson of the Hudson River Tunnel, when his ears began to be "blocked up" in passing through the lock, and yesterday morning, when arising from bed, the left ear was painful and felt "blocked." The entire head soon ached, and pains extending down the back. In a short time pain and pressure were experienced in the right ear. On reporting at the works their physician gave him cotton saturated with some fluid to use in his ears, but the pains continued to get worse. Patient worked for four hours, and then rested for nine hours, while employed.

Examination shows the left drum-head to be very hyperæmic, the posterior superior quadrant bulging, more highly congested in one spot, which seems on the point of giving way. The right drum-head is very hyperæmic at upper border and down the malleus plexus. He has decided nasal catarrh, and the mucous membrane of the throat is very vascular and thickened. Hears loud voice only in either ear. Is autophonous in the right ear.

CASE 4.—John D——, aged 23, came to New York Eye and Ear Infirmary, January 29th, 1883. States that after working in Hudson River Tunnel for six months his right ear began to trouble him and

he had to stop working; it has been discharging for three months. The left ear began to discharge also about a month ago—two months after leaving the tunnel-work.

The discharge in right ear began with otalgia; the left ear has not pained. The tinnitus is very distressing, but intermits. On beginning work the right ear got "blocked" on going into the "lock," and felt "dumb" for a month afterward. In fact, both of his ears often got "blocked," but by blowing his nose, or holding it over steam, the sensation of being stopped up in his ears passed off. He worked in water much of the time, and was much exposed. Confesses to syphilis and intemperance. Examination shows that a perforation exists in anterior superior quadrant of left ear. Canal of right ear narrowed to a slit-like passage, so that drum-head cannot be seen; both canals contain purulent matter. He has very decided nasal catarrh.

CASE 5.—Michael McC——, aged twenty-six, came to the infirmary, April 12th, 1887. Was never deaf before being employed on the Harlem River bridge. He entered the caisson under Harlem River a month ago, and remained at work one "shift" of eight hours only. The pressure was considerable, but the exact amount was not known. He states that soon after going into the lock, with two other laborers, air began to be forced in. He began to feel very uncomfortable; thought his head would "blow off;" his eyes seemed to "pop out," and his ears "cracked." The "boss" told him to hold the nose, close his mouth and not to breathe. He tried to follow these directions for a couple of minutes, and on taking his hand from the nose it bled. He then shouted to be let out, but the men in the lock said he would soon get used to it, that the first time was the most severe. But the distress continued, and while thus holding the nose and shouting out for relief some thirteen minutes, he was let into the caisson under the river, where he worked for eight hours, though very dizzy and weak in the back. On coming out of the caisson he was very deaf—felt as though he could not speak. He speaks very loud, for fear others will not hear. These symptoms remain, and he has "cracking" in ears on swallowing. Has had pains for two days about the outer canthus of right eye.

Hearing: Loud voice only in right ear at twenty feet; left ear low voice, if plain.

The drum-heads are dry, lustreless-looking, and greatly blackened with dust, the atmosphere of the caisson being full of gunpowder smoke. The short process, and the handles of the malleus on both sides look bleached, and stand out in strong relief from the blackened membranes. The dermic layer of the right drum-head is blistered off in places, especially behind the short process. There are new blebs on anterior segment, and posteriorly on the flaccid membrane.

Patient had long been a hard drinker, and for a week before working in the caisson had had a severe head cold. Ever since the injury he has been "spreeing," and the head catarrh has not abated. The

teeth are pretty bad, and he has been subject to nasal catarrh for a long time.

The cause of aural trouble among caissonists is evident from a study of the foregoing cases, when the disturbances produced by high air-pressure on the organ of hearing are considered. Thus, the usual intra-tympanal air-supply having been cut off by closure of the guttural mouth of the Eustachian tube (as from head colds due to exposure, or naso-pharangeal catarrh, or, perhaps, from condensation of pharyngeal air), it is found that the effect of great aërial pressure upon the outer surface of the drum-head is to force it inward. This causes undue tension of the transmitting mechanism, as well as congestion or inflammation of the drum. As the air of the drum decreases by absorption, or escapes into the Eustachian tube in consequence of unusual outward pressure, retraction of the drum-head, of course, gives raise to pain, deafness, tinnitus, vertigo, and other distressing symptoms in the ears and head. Where there is a collection of wax in the auditory canal it is extremely liable to become softened in such a humid atmosphere, especially if perspiration be free, and when loosened in this manner the plug becomes, as in one of the above cases, impacted against the drum-head, causing great discomfort. Through carelessness in charging the lock with condensed air, and the neglect of its inmates during the process to maintain tympanal air-renewal (by making frequent efforts to inflate the drum when the nose is held closed, by blowing air from the lungs up into the head while the mouth is closed), much aural trouble is likely to be experienced by any one exposed, though having sound ears, for during the loss of equilibrium the strain upon the parts gives rise to more or less hyperæmia. Rupture of the drum-head is said to be possible under these circumstances, but such a result must be exceptional unless condensation is very sudden.

On going out from the lock into air of ordinary tension compressed air may remain confined in the drum, and on its expansion the drumhead is liable to be forced outwardly. Such being the fact, it behooves persons, in passing out of a caisson-lock where high pressure is maintained, to exercise care as on going in. But where great tension—from forty to sixty pounds—is required, as in tunnel-work, it seems probable that unpleasant effects on the ear can scarcely be avoided, and the greater number who have pre-existing aural trouble will be liable soon to become more or less incapacitated. Men seeking employment in this work, as in any, would often conceal their aural or other physical defects, as well as fail to report any dis-

ease incident to the exposure of their unhealthful occupation, and unless a competent medical examination be made of every man before being employed, and at frequent intervals afterward, great injustice may be done to the laborer himself. Deaf persons are, moreover, incompetent in any capacity where their own and others' safety may depend on hearing what is said to them in emergencies. Defective persons, such as have been reported above, are manifestly unfit to be employed in work under highly compressed air.

THE EFFECT OF SUBMARINE DIVING ON THE EAR.

In tropical and semi-tropical countries a large number of persons engage in submarine diving for a livelihood; pearls and sponges, for example, being obtained in this way. Travellers in those countries are familiar with the practice among the natives of frequently diving in sport, and it would be of interest to know to what extent their ears are affected.

The writer requested his friend, Rev. E. B. Cotton, of Quincy, Mass., to make inquiries in respect to the effect of prolonged exposure to deep-sea diving, during a sojourn in Italy some years ago; curiously enough Mr. C. found that many of the pearl divers experience much inconvenience in pursuing their occupation until the drum-heads are ruptured, and "water goes from ear to ear"—the meaning of which is, that the discomfort from the pressure of water on the drum-heads at a great depth is almost unendurable to certain persons, but that this ceases so soon as a free passage is opened from the throat outward through the ear. In a number of instances, persons have informed the author that, when diving about fifteen feet below the surface of the water, they have experienced much discomfort in their ears. One can, therefore, easily understand how much distress would be occasioned to the diver in six or seven fathoms, or thirty-six to forty-two feet of water, owing to the tremendous pressure on his drum-heads.[1]

A diver, in relating his experience to the writer, said that on one occasion he dove six fathoms (thirty-six feet) in the river Indus,

[1] Commander Henry C. Taylor, U. S. Navy, has seen men dive some seven fathoms, after pearls, in the Red Sea, and remain under water about three minutes. Dr. Delavan Bloodgood, Medical Director U. S. N., who has timed pearl divers in Pichelinque Bay, Gulf of California, informs the writer that the usual time of submergence, as observed by himself, was a few seconds less than two minutes in five or six fathoms of water, two minutes being exceptional. He thinks that three minutes must require special exertion.

India. He felt unpleasant fulness in the right ear for an hour afterwards. A native doctor tried to relieve the symptoms by sucking the water out of the external auditory canal with an apparatus used for that purpose, but he has heard very badly in that ear ever since.

A considerable number of patients have, from time to time, presented themselves at the Infirmary with the statement that the ear has been injured by diving or while submerged in diving-bells or diving-armor, but the facts are generally so meagre that a differential diagnosis, as between this alleged causation and pre-existing aural disease, is difficult.

The effect of going up rapidly by rail into the rarefied air of mountains is described by travellers as occasionally causing considerable discomfort. Such an experience could scarcely occur to persons with normal ears, but where intra-tympanal air-renewal was difficult, especially in neuropathic or run-down individuals, it might contribute very much to their distress.

THE EFFECT OF SUDDEN RAREFACTION OF AIR EXTERNALLY TO THE DRUM.

This may occur in the manner shown by the following case:

The patient, a male, 26 years of age, five days before coming had pressed the end of the little finger well into the left external auditory canal (which was large), and then withdrawn it suddenly. The act occasioned a report like the sound emitted in uncorking a bottle. There was immediate tinnitus, numbness about the ear, and autophonia, all of which combined to cause him great distress. The strain, as shown by the examination, was found to have given rise to inflammation of the drum-head, which was also much relaxed below the umbo.

CHAPTER XX.

INJURIOUS EFFECTS OF UNSKILFUL TREATMENT OF THE EAR, ESPECIALLY FROM EFFORTS TO REMOVE FOREIGN BODIES.

The author's condemnation of the meddlesome treatment in rupture of the drum-head from blows, but feebly expresses his disapprobation of the forcible methods sometimes resorted to, in the search for foreign bodies in the ear. There can be no more pitiable object than a child, terror stricken and exhausted with fear, struggling in a frenzied way whilst the ear is painfully lacerated in unskilful attempts at the removal of a foreign body. The chief harm in these cases is not always caused by the foreign object, nor yet entirely by the injury, but by the shock; shock, followed by nervous exhaustion, due to the infliction of needless pain, the subjective phenomena of autophonia and tinnitus often experienced, and the behavior of sympathizing and excited persons about them. The feverishness from the causes mentioned remind one of the condition of unfortunate children who have been mercilessly cauterized for the bite of alleged rabid animals.

In order to fully comprehend the magnitude of prevailing ignorance in respect to medical knowledge among a large number of the laity, we may go back a couple of centuries in medical literature for an admirable description. And in no department was ignorance more manifest than in the treatment of aural diseases. Thus, to the entrance of a harmless object in the ear was attributed a train of evils which may fairly be traced to the *treatment* (*sic*) for it removal. The case is an historic one, and may, with profit, be given here in full; it is cited by Du Verney,[1] in speaking of the various symptoms depending on the presence of foreign bodies in the ear. He says, in alluding to convulsions and swooning, "For an

[1] A Treatise of the Organ of Hearing: Containing The Structure, The Uses, and The Diseases of all the Parts of the Ear. Translated from the French by John Marshall. London, 1737, p. 101 et seq.

Example of a great Pain in the Ear, accompanied with violent Symptoms, I shall content myself with only giving you the fourth Observation of the first Century from *Fabricius Hildanus*, because it includes all the principal Symptoms. A young Girl, twelve Years old, having by chance let a Glass-Ball enter into the Hole of her left Ear, *which could by no means be extracted, was seized with acute Pains, which were communicated to the same Side of the Head:*[1] These Pains, after a long space of Time, did produce a Numbness in the Arm and Hand, afterwards in the Thigh and Leg, and at last in all the left Side. This Numbness was accompanied with very great Pains, which increas'd in the Night and in cold and wet Weather, with an Irregularity in her *Menses*, with Epileptic Fits, and with an Emaciation of her left Arm. *Fabricius Hildanus* eight Years after extracted the Glass-Ball, and then all the Symptoms ceased, to which all the other Remedies which were us'd for so long a time could not give the least Ease."

"Many Remarks," says Du Verney, "might be made upon this Observation; but as I have explain'd the greatest part of its Symptoms, I shall apply myself to some which are particular in this Case. The Pains and Convulsions seiz'd on all her left Side to the end of her Foot. *Hildanus* has explain'd this *phenomenon* by saying that the *Portio Dura* is distributed along the Arm, and to the Thigh: But as this Distribution is imaginary, I shall endeavour to give a Reason more suitable to the Parts. I therefore think that the Irritations and irregular Motion of the Spirits had past into all the Nerves of the *Medulla* on this side, by the Communication of the second Vertebral Pair: This is what would not have happen'd if the Irritation had been communicated to the Brain; for then there is Reason to imagine that this Girl would have suffer'd Pains and Convulsions in all Parts of her Body: From whence I suppose the left Side of the *Medulla* to be only affected: it is easy to conceive how this Indisposition should pass into the Arm and into the Leg, since we know that all the vertebral Nerves of the same Side communicate with one another by transverse Ramifications, after they have passed out of the *Foramina* of the *Vertebræ*."

"All the Symptoms increas'd in the Night and in wet weather, because the Humidity of the Air puffing up the Glands and the Membranes of the Passage, made it more closely embrace the Glass-Ball, which increas'd the Irritations."

"After the Glass-Ball was extracted, the Irritations which it caus'd ceas'd, and consequently the Pains and Convulsions: The Spirits re-

[1] Italics the writer's.

covering their common Course, insensibly dissipated all the extraneous Bodies, which caus'd the Arm to regain its Motion and pristine Vigour." Du Verney, after the above explanation, says: "I now come to the Means which are to be us'd in the Cure of this Distemper" —meaning in a general way the pain, vertigo, and subjective phenomena accompanying all "Disorders of the Hearing Organ." The pain arising from "Cold" must be met with warmth "as thick Wool or hot Bread, which may also be steep'd in Spirits of Wine; but," he says, "the Pain seldom yields to these first Remedies, and then we must be oblig'd to proceed to the general Remedies: Bleeding is necessary to hinder a Collection of these Bodies, which the Cold has detain'd; and as for Purging, it is not to be order'd till the violence of the Pain is diminish'd. During their Use, Fomentations are very successfully employ'd, or Injections composed of the Juices or of the Decoctions of *Baum, Hyssop, Calamint, Origany, Marjoram,* in which we may mix some Drops of Bullock's Gall, or rather some Drops of bitter *Almonds,* or *Camomile, Cloves, Aniseeds,* etc. Authors very much recommend the stopping the Ear with Cotton perfum'd with Musk; there is no Difficulty in explaining the Effects of these Remedies, they are all endued with a very penetrating volatile Salt, which warming these Parts, open the Pores, and the Ducts of the Glands, and cause the Substance to flow, which was before retain'd by the Cold."

"The Pain which proceeds from Heat," the author goes on to say, "is most commonly cur'd by general Remedies, especially by Bleeding, which is absolutely necessary to hinder a Fluxion and an Inflammation, which might happen to the Part. During the Use of these Remedies, we may with great success make use of Injections compos'd of Milk, that of a Woman is better than any other, when it is mix'd and beat up with the White of an Egg; besides this, they make their Injections of some cooling and emollient Decoction, in which they drop some Oil of sweet Almonds; the Yolk of an Egg is very much commended by *Devigo.*" Poultices, narcotics, "the Water of *Carduus Benedictus,* or blessed Thistle, is us'd, in which, Woodlice, Earthworms, and Ants Eggs, etc., are boil'd: We may add, a few Drops of Oil of Box."

The above represents the accumulated lore of two hundred years ago. It seems absurd to us now, but the preparations, proprietary and otherwise, in use at the present day contain among them agents of as little value, and some even more harmful, as will be shown directly. The location of the middle ear at the bottom of a narrow, tortuous canal, usually quite invisible without the skilful employment

of special apparatus, should insure its protection from meddlesome and unskilful treatment. But the contrary of this is true, since the affections to which it is subject are of a nature so painful that either lay or medical aid is generally most urgently demanded; and this assistance often comes from persons whose knowledge is excelled by their zeal and energy. As will be seen further on, there are but few fluids, benign or irritant, that have not been introduced into the unknown regions at the bottom of the "hole" leading down to the middle ear. But many are not content with this, for, on seeing that medicaments put into the ear are not followed by relief (!), resort is had to either internal or external medication, or to both at the same time.

Of the former it need only be said here that, whilst a prompt and effective dose of some quieting remedy is often demanded, the long-continued and temporizing employment of these is often not only useless, but positively harmful. But, in respect to the latter, almost as much harm may ensue as from the introduction of miscellaneous irritants directly into the deeper parts of the ear.

The author, in looking over his notes in respect to this matter, finds a large collection of badly managed cases which, were space allowed, could be arrayed as a formidable protest against interference. Among these are cases of indiscriminate *blistering* about the ear with some preparation of cantharides; as upon the mastoid process, the side of the neck, or elsewhere about the ear, for "buzzing" or other noises, chronic catarrh, acute and chronic purulent inflammation of the middle ear, various acute and chronic processes of the external auditory canal, otalgia, "numbness," and "deafness." In some instances, blisters were clapped on over the whole region of the ear; in others, the mastoid was blistered once a week, or oftener, for a longer or shorter period of time. The employment of croton oil, tartar emetic ointment, tincture of iodine, mustard, and the like, produces a similar effect to cantharides.

Leeching.—To the effects of abstracting blood from about the ear much praise has been given, but the fancied relief is often attributable to that faith too often accorded to energetic efforts of any kind from which relief is anticipated. Leeches, like blisters, when vaguely employed about the ear, in the hope of doing good, are often positively harmful. The presence of those offensive and sanguinary worms terrifies children and is, indeed, abhorrent to most nervous people; that the fright they cause may drive away pain, as the sight of the cold steel forceps of the dentist often abates a toothache, goes

without saying, though, unlike the latter, they do not strike at the root of the trouble.

The abuse of this practice would be amusing were it not for its gravity; thus leeches are sometimes applied upon the cheek, or wherever their fancy takes them when turned loose. The writer has often seen a number of woe-begone children, sitting in a row at an outdoor clinic, with leeches attached all about their ears, the worms wriggling and squirming, sucking blood from the terrified patients. On one occasion, a leech was put into the lumen of the external auditory canal, for the relief of the pains attending acute inflammation of the middle ear. The worm, after exploring the canal, attached itself to the drum-head and, becoming gorged with blood, finally filled the canal. Some difficulty was experienced in arresting the bleeding from the bite, the same being enough to cause some alarm.

The author has seen cellulitis and abscess resulting from the bite of leeches; and bleeding from the wounds they make, often arrested with difficulty, is sometimes alarming.

The remote abstraction of blood from the cheek, in front of the tragus, or even from the concha, will not permanently relieve congestion of the deeper parts; and, moreover, it is not the stagnant blood that is withdrawn, but the more freely circulating fluid. In a certain number of cases, the bite of the leech seems to give rise to irritation, and what wonder that it does when we consider that its mouth, according to Baird, is provided with three jaws, and "each of these is armed, on its edge, with two rows of very fine teeth, which penetrate the skin by a motion resembling that of a semi-circular saw."

The writer, finding the use of leeches unsatisfactory, has long since ceased to use them, though their employment is still sanctioned by well-known authorities.

Cupping about the ear, once much in vogue, like the employment of leeches, is justly falling into disuse.

Wilde's incision, a well-established surgical procedure, indicated in periostitis externa or abscess of the mastoid, is often needlessly done. Cases of this kind, where irritating tents were employed to keep the wound open long after the indications for its existence had disappeared, are not scarce.

Poulticing and steaming the ear is sometimes practised with a misguided energy that leads to deplorable results. Protracted steaming of the side of the head over a basin of hot water or otherwise, renders the patient very susceptible to subsequent exposure to draughts. Besides the large crops of boils and pimples which often break out on and about the auricle from this cause, increasing the discomfort

of the patient, the author has observed cases much aggravated in this way; in three of them facial paralysis resulting (see Chap. XV., p. 313). In two instances the ear had been poulticed continuously "for earache:" in the one case, for ten days, in the other, five or six times daily for a period of two weeks; in both of these cases much harm had been done.

Syringing the Ear. The evil arising from aimless syringing for acute and chronic inflammation, tinnitus, and "deafness," is, upon the whole, perhaps, no less than from the causes already enumerated. Cases have come under observation where this procedure has been kept up, at longer or shorter intervals, for weeks or months, and for otorrhœa it is often the only treatment practised for a long time.

The rude injection of water into the ears of children, especially when acutely inflamed, is a cruel and reprehensible procedure, for which physicians as well as parents are responsible.

The cure of purulent inflammation of the middle ear is often greatly protracted by persistent syringing and douching of the parts; and such treatment is particularly absurd where the seat of trouble is beyond the reach of fluids injected into the atrium.

The introduction of irritants into the ear. It would scarcely be possible, even though desirable, to enumerate all of the irritating substances that have been put into the ear as medicaments; spirits of hartshorn, spirits of camphor, chloroform, oil of turpentine, whiskey, brandy, croton oil and the like, are among the most common employed in this manner.

Substances, comparatively harmless in themselves, are frequently introduced into the ear on account of their alleged virtues which, if not directly irritating, are usually uncleanly, and obstruct the canal. Among these are various oleaginous substances derived from animals, fish, serpents, and the like. Black sheep's wool, the heart of a roasted onion, baked dough and honey, sweet oil and laudanum, and the like. Anything at hand may be thus put into the ear in emergencies, as the more or less irritating popular medicines of the day. Miss M., aged 34 years, came to the writer with the statement that she had heated vaseline "cream" in a spoon, and poured several drops into each ear to relieve the tinnitus due to a head cold. There was instant deafness, an increase of tinnitus and autophonia, also some pain. The appearance of the fundi was most puzzling, until the patient gave the above history, since the "cream" was spread out evenly over the drumheads, giving them a waxy look. The symptoms disappeared as soon as the foreign substance was removed by syringing with warm water. Another instance was that of a

girl 4 years of age, whose mother had introduced hot lard into the ears, a custom prevailing in that neighborhood.

"*Catarrh snuffs*" are much employed by persons having intercurrent attacks of rhinitis; the local irritation of these has been known to excite aural trouble.

The galvano-cautery applied to the naso-pharynx and other heroic operations in the nasal region, are too frequently followed by inflammation of the ear for the latter to be regarded as coincidental.

The abuses but briefly alluded to above cannot be too severely condemned. The writer has seen patients who were unfortunate enough to have been blistered, leeched, violently syringed, and also treated at the same time with irritating instillations, until what in the beginning was a simple case had become speedily converted into one of grave character.

It is by no means an uncommon practice to recommend solutions of carbolic acid, washing soda, and the like, to be instilled or syringed into the ear without explicit directions being given, with the result of greatly harming the ear. In one instance, a lady who had been directed to drop some sweet oil into the ear, picked up, in the dark, a concentrated solution of carbolic acid, which the doctor was using on the os uteri, and turned some of it into the ear, cauterizing the concha and canal and side of the face severely. In another case a similar mistake occurred, a strong solution of the acid being mistaken for a weaker one, when acute inflammation was set up in the middle ear, the patient subsequently dying from its effects. In still another case the patient poured a concentrated solution of carbolic acid into the ear, from the effects of which an otorrhœa still exists.

Examples of brutal treatment are numerous enough, but the following cases are all that space will allow:

CASE 1.—Mr. T., an Alabamian, 29 years of age, was sent to the writer in August, 1880, on account of otorrhœa of nineteen years' standing. He stated that, when about ten years of age, he was subject to earache, for which the *blood of a bug, obtained by pinching off its head, was dropped into the ears.* Some years later he was taken for treatment of an eczema of the auricles to a physician, who used the syringe with such force as to knock the patient down, and rupture the drum-head (see page 221).

CASE 2.—A man, 31 years of age, came to the New York Eye and Ear Infirmary with the following history. He took a Russian bath a week ago for a head cold. After the cold plunge he felt that water had entered the left ear, and pains were soon experienced. Later on there was a serous discharge from the ear, and he noticed disagreeable noises and autophonia. These symptoms were abating on the

third day, but he thought it best to obtain medical aid. The physician consulted informed him that "the water was still in the ear," and proceeded to treat him by the application of electricity—the patient being directed to hold one electrode whilst the other was retained in the left hand by the doctor. The latter then closed the circuit by pressing a finger of his right hand into the patient's ear. This treatment was alternated by a novel method consisting of boxing the patient on the ear while he kept his mouth open; but it soon became unbearable. An ear spoon was then pushed down into the ear and the deeper parts were scraped for wax, causing intense pain. When the patient could endure no further "treatment" he was provided with an "aurilave" and instructed to "scrape the ear thoroughly." The case, of course, suffered a severe exacerbation from this treatment.

The following is a case of wounding the drum of the ear to avoid conscription:

CASE 3.—A Pole, 33 years of age. was conscripted for service in the Russian army two years ago. Has recently come to the United States. He says that in order to secure exemption from service he determined to establish a claim to disability. To accomplish this he employed a physician in his native town to mutilate the left ear so as to cause a discharge and make him deaf. This was accomplished by the use of a strong acid which was introduced into the ear on cotton-wool, with directions to remove it in a little while. The acid was allowed to remain in the ear for a day, however, and a discharge was established. The board of army surgeons who examined him two weeks afterwards refused to exempt him from service, believing the ear would get well. Under these circumstances the doctor who injured the ear did not collect the fee of about eight dollars which had been agreed upon.

Examination shows that purulent inflammation of the middle ear still exists, and that the drum-head, which is much thickened, has a large perforation in the posterior inferior quadrant.

Imaginary foreign bodies in the ear. The presence of objects in the ear is often suspected, and much harm is done in attempts at removal, where an examination shows that none were present, as in the following:

CASE 4.—Male, two years of age. The mother observing that the child while playing had placed a number of tacks which it had abstracted from a toy tool chest, in the concha of the left ear, held the ear downwards until they fell out. Believing, however, that she detected the presence of some remaining in the canal, the child was taken to a neighboring drug store where a clerk made further attempts at removal. A doctor, happening to come in, undertook to get the tacks out with a metal ear-spoon, wrapping the terrified child in a sheet to control its struggles. The ear bled freely during the manipulations made, and the mother could "hear the spoon grate

against something." Not being able to remove the objects, the doctor sent the patient to the New York Ear Dispensary, where the writer saw him, on February 24th, 1873. After the child had been placed under ether, the ear was examined, when it was found that no tacks were present, but that the drum-head and walls of the canal had been lacerated greatly and were scarcely distinguishable. The acute purulent inflammation which followed ran the usual course, but whether any deafness resulted from this rude treatment was not ascertained.

CASE 5.—*Death following attempts to remove a foreign body.*

A girl, 16 years of age, employed by the U. S. Cartridge Company, Lowell, Mass., in October, 1886, was, while asleep, struck upon one of her ears by some object thrown by a comrade to wake her up. She claimed that the missile had been a cartridge, and that the ball went into the ear. "A day afterwards," says Dr. J. C. Irish, who reported the case to the writer, "two physicians made strenuous efforts to extract the ball that was supposed to be in her ear, and failed. In two or three days after this interference with the ear, Mary died of meningitis. I made the post-mortem examination. The membrana tympani had been destroyed. There was no ball in the ear or brain, and never had been. Death was due to meningitis. . . ." Other accounts state that "she suffered intensely, became wildly delirious, and died . . . in great agony."

The fright in a case of this kind sometimes is quite as injurious as as unskilful manipulations; though the former is likely to be due to the latter.

Persons often fancy that pins, and the like employed in scratching the ear, have been left in the external auditory canal. The writer has observed several instances where considerable alarm has arisen from this cause, patients stoutly insisting that the object remained in the ear after being assured there was none present.

Cauterizing the auricle for pains experienced in other parts of the body is a custom sanctioned by the old masters. It has also been practised in modern times; thus Dr. G. Finco,[1] of Padua, speaks rapturously of the results of this treatment in forty-eight cases of his own, thirty being cured in a few days by a simple application, ten somewhat relieved, and eight unsuccessful. The treatment was not, however, confined to cauterization. This old operation has also been revived by C. Lange,[2] who reports seven cases. He employed Vienna paste in cauterizing, and claims to have benefitted cases of sciatica of peripheral origin.

Piercing the lobule for weak eyes, etc., is a popular custom, espe-

[1] Gaz. Méd. Ital. Lomb., Nos. 38–41, 1861.

[2] Cited in Schmidt's Jahrbücher, No. 2, p. 128, 1881.

cially on the continent of Europe, but not practised in this country unless among females, who nearly all submit to the operation for the purpose of wearing rings in their ears.

The benefits arising from either cauterizing or piercing the ear are but small indeed, and deserve but little less attention than was given an Italian, in Boston, who was arrested a few years ago for applying a hot iron to the ears of children for the cure of toothache.

The application of blisters to the mastoid for the relief of objective symptoms has been known to cause irritation of the middle ear, and the reflex irritation then set up in deeper parts is comparable to the disturbance created by dental irritation.

The energetic use of syringe, air douche, and irritants with the view of eradicating aural disease *per abusum*, is a serious and unpardonable abuse, and is, moreover, of such frequent occurrence that the considerable space given the subject seems advisable.

Introduction of foreign substances into the ear with malicious or murderous intent. Cases where *molten metals*, such as lead, iron, etc., *acids*, and other substances, have been poured into the ears of persons by others with malicious intent, are rare; they are, however, occasionally met with. The injury in many such cases is not only sufficient to completely destroy the transmitting mechanism of the ear, but may result in the death of the injured person.

The following case was reported by Alley:[1]

Patient, a male, was awakened, after a fit of intoxication, by an unpleasant feeling about the head and right ear. Examination showed that a quantity of melted lead had been poured into the ear while he was in a state of insensibility. The metal was very firmly imbedded; it could not be removed. Pain was not severe. There was facial palsy on the same side and deafness. A profuse purulent discharge developed. Patient returned to work two weeks later, with the lead still in his ear. When seen some eighteen months afterwards, the condition of the patient, both objectively and subjectively, was the same.

[1] American Journal of the Medical Sciences, Vol. xxiii., 1852, p. 376.

CHAPTER XXI.

CLAIMS OF SOLDIERS, SAILORS, AND MARINES FOR PENSIONS ON ACCOUNT OF DISABILITY FROM DEAFNESS.

From the considerable number of cases of ear disease coming to the notice of the author since the late war between the States, in persons having seen active service in the army and navy, he has been led to believe that the total number deserving pensions for this disability must be quite large. In reporting a bill to the Forty-ninth Congress, 1886, to increase the rate of pension for deafness, the Senate Committee on Pensions found that in 1883 the number of totally deaf on the rolls was one hundred and seventy-seven, and the number of partially deaf was one thousand three hundred and ninety-seven, a very small ratio of the large number of pensioners.

Under the present law, $13 per month (a full pension) is the whole amount allowed for total or severe deafness of both ears, with a proportionate amount for partial loss of hearing in one or both ears.

The accompanying tabular statement was presented to Congress by the committee.

This number, however, has been very considerably increased since the report was made. According to a communication from Commissioner John C. Black to Capt. Wallace Foster, of Indianapolis, to whom the writer is also indebted for the report of the committee, there were, on March 1st, 1886, 1,230 persons drawing pensions for total deafness, and 4,159 persons drawing pensions for partial deafness, a total of 5,389.

Statement of rates for the disability of total and partial deafness with the aggregate for each

RATES.

States and Territories.	$1.00	$1.87½	$2.00	$2.12½	$2.50	$3.00	$3.75	$4.00	$4.25	$4.50	$5.00	$5.33⅓	$6.00	$6.25	$7.00	$7.50	$7.75	$8.00	$8.50	$8.75	$10.00
Maine	3	..	4	..	..	..	..	11	..	..	..	..	12	..	..	..	..	3	..	..	3
New Hampshire	..	..	7	..	..	..	..	4	..	..	..	..	..	..	..	..	..	4	..	..	2
Vermont	1	..	4	..	..	1	..	3	..	..	1	..	7	..	..	..	..	1	..	..	..
Massachusetts	4	..	12	..	..	..	..	10	..	..	1	1	15	1	..	1	..	4	..	..	1
Rhode Island	..	..	..	..	..	..	..	3	..	..	..	..	2	..	..	..	..	1	..	..	..
Connecticut	1	..	5	..	..	..	..	4	..	..	..	..	3	..	..	..	..	2	..	..	2
New Jersey	3	..	3	..	..	..	..	12	..	..	..	..	8	..	..	..	..	..	..	..	..
District of Columbia	2	..	4	..	..	..	..	7	..	..	..	..	5	..	..	..	..	5	1	..	..
New York	9	..	34	..	..	2	1	40	..	..	3	..	25	1	..	2	..	20	2	..	2
Pennsylvania	3	..	25	..	..	2	..	32	..	..	5	..	36	..	..	1	1	2	1	..	3
Ohio	8	..	32	..	..	..	..	46	..	..	3	..	20	..	..	1	..	15	2	1	5
Illinois	7	1	28	1	..	1	1	34	1	..	5	..	40	..	1	..	..	27	1	..	5
Iowa	1	..	22	..	1	1	..	27	..	..	..	..	27	..	1	..	..	15	..	..	4
Indiana	14	..	23	..	1	..	..	29	..	1	2	..	16	1	..	..	..	13	..	..	2
Michigan	5	..	10	..	..	..	1	15	..	..	1	..	15	..	..	..	..	15	..	..	2
Wisconsin	2	..	5	..	..	..	..	19	..	..	1	..	17	..	..	..	..	4	..	..	5
Minnesota	1	..	2	..	..	1	..	9	..	..	..	..	6	..	..	..	..	2	1	..	..
Kansas	1	..	7	..	..	3	..	13	..	..	2	..	7	..	..	1	..	..	..	..	5
Colorado	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	1	1	..	..
Nebraska	..	..	5	..	..	..	..	6	..	..	..	..	2	..	..	..	..	2	..	..	..
California	1	..	1	..	..	..	..	1	..	..	..	..	1	..	..	..	..	2	..	..	1
Oregon	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	..	1	..
Indian Territory	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Dakota Territory	..	..	1	..	..	..	..	2	..	..	..	..	4	..	..	1	..	2	..	..	1
Montana Territory	1	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Washington Territory	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Idaho Territory	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..
Arizona Territory	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Wyoming Territory	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Delaware	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
West Virginia	..	..	†3	..	..	1	..	8	..	..	1	..	4	..	..	..	..	1	..	..	..
Virginia	..	..	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..
Maryland	..	..	2	..	..	..	..	4	..	..	..	..	2	..	..	..	..	1	..	..	..
North Carolina	..	..	1	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Georgia	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Mississippi	..	..	2	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Louisiana	..	..	2	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	1
Arkansas	..	..	1	..	..	..	..	1	..	..	..	..	2	..	..	..	..	1	..	..	..
Texas	..	..	1	..	..	..	..	2	..	..	..	..	1	..	..	..	..	..	..	..	..
Tennessee	2	..	5	..	..	..	..	6	..	..	..	..	3	..	..	..	..	1	..	..	1
Kentucky	1	..	6	..	..	..	..	5	..	..	2	..	3	..	1	1	..	2	..	..	..
Missouri	3	..	4	..	..	..	..	13	..	..	..	..	10	1	..	1	..	3	1	..	2
Province of Quebec, Canada	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wurtemburg, Germany	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Total	75	1	263	1	2	12	3	376	1	1	27	1	299	4	3	9	1	153	10	2	48

Rates amounting to more than $13, marked thus +, is for deafness and other disabilities, or a

State and Territory having deaf pensioners. Compiled from the official pension list of 1893.

RATES.

$10.50	$11.00	$11.25	$12.00	$12.50	$12.75	$13.00	+$14.00	+$14.75	+$15.00	+$16.00	+$17.00	+$18.00	+$18.25	+$18.75	+$20.00	+$24.00	+$25.00	+$30.00	+$37.50	+$50.00	+$62.00	+$72.00	Total deaf.	Partial deaf.	Total number.
...	...	...	1	...	...	1	2	...	1	...	1	2	1	...	...	...	...	...	...	...	...	...	7	38	45
...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1	17	18
..	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	4	17	21
...	...	...	2	...	1	7	1	...	...	...	1	2	...	...	...	...	...	...	...	...	...	...	13	51	64
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	6
..	...	...	...	...	...	3	...	...	...	...	...	2	...	...	...	...	...	...	...	1	...	...	8	14	22
...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	23	27
...	...	...	1	...	...	1	...	...	2	...	...	...	...	...	...	1	...	...	...	...	...	...	6	22	28
...	...	1	8	1	...	12	1	...	2	...	1	4	...	1	...	...	...	1	...	...	...	...	23	150	173
...	1	...	4	...	1	11	1	...	...	2	3	1	...	...	...	...	...	...	...	...	...	...	15	119	134
...	...	1	5	1	...	11	1	...	3	2	2	3	...	...	...	1	...	1	...	...	...	1	19	146	165
...	...	...	7	2	2	5	...	...	2	...	2	3	...	1	1	2	...	...	...	...	...	...	7	174	181
...	...	...	5	...	1	4	1	1	...	...	3	3	...	...	...	...	...	...	...	...	...	...	6	111	117
...	...	...	1	...	...	5	1	...	1	...	1	4	...	...	...	3	...	...	...	1	...	...	8	111	119
...	...	...	4	...	...	6	1	...	2	...	1	5	...	...	1	...	1	1	1	...	...	...	10	75	85
...	...	...	4	...	...	...	2	...	2	1	1	2	...	...	...	...	...	...	...	...	...	...	...	64	64
...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	3	21	24
...	...	...	4	...	...	3	...	...	3	...	1	...	...	...	2	1	1	...	...	...	...	...	10	44	54
..	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5
...	...	...	...	...	...	2	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	3	15	18
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7	7
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	3	4
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	...	4	9	13
...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	3
...	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18	18
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	3
...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	12
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4
...	...	...	...	...	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	1	...	...	2	2	4
..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5
...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	2	5	7
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	4
...	...	...	1	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	21	21
1	...	...	...	...	...	6	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	8	23	31
...	...	...	3	1	...	3	1	...	...	...	1	4	...	...	3	...	...	1	...	...	...	...	10	44	54
...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
1	1	3	53	5	5	86	14	1	19	7	17	38	1	3	8	9	2	4	1	3	1	1	177	1,397	1,574

combination of disabilities including deafness; $13 per month a full pension for total deafness.

Statement of rates for the disability of total and partial deafness with the aggregate for each

RATES.

States and Territories.	$1.00	$1.87½	$2.00	$2.12½	$2.50	$3.00	$3.75	$4.00	$4.25	$4.50	$5.00	$5.83½	$6.00	$6.25	$7.00	$7.50	$7.75	$8.00	$8.50	$8.75	$10.00
Maine	3	..	4	..	..	..	..	11	..	..	..	..	12	..	..	..	..	3	..	..	3
New Hampshire	..	..	7	..	..	..	..	4	..	..	..	..	..	..	..	..	..	4	..	..	2
Vermont	1	..	4	..	..	1	..	3	..	..	1	..	7	..	..	..	..	1	..	..	..
Massachusetts	4	..	12	..	..	..	..	10	..	..	1	1	15	1	..	1	..	4	..	..	1
Rhode Island	..	..	..	..	..	..	..	3	..	..	..	..	2	..	..	..	..	1	..	..	..
Connecticut	1	..	5	..	..	..	..	4	..	..	..	..	3	..	..	..	..	2	..	..	2
New Jersey	3	..	3	..	..	..	..	12	..	..	..	..	8	..	..	..	..	..	..	..	..
District of Columbia	2	..	4	..	..	..	..	7	..	..	..	..	5	..	..	..	..	5	1	..	..
New York	9	..	34	..	..	2	1	40	..	..	3	..	25	1	..	2	..	20	2	..	2
Pennsylvania	3	..	25	..	..	2	..	32	..	..	5	..	36	..	..	1	1	2	1	..	3
Ohio	8	..	32	..	..	..	..	46	..	..	3	..	20	..	..	1	..	15	2	1	5
Illinois	7	1	28	1	..	1	1	34	1	..	5	..	40	..	1	..	..	27	1	..	5
Iowa	1	..	22	..	1	1	..	27	..	..	..	..	27	..	1	..	..	15	..	..	4
Indiana	14	..	23	..	1	..	..	29	..	1	2	..	16	1	..	..	..	18	..	..	2
Michigan	5	..	10	..	..	..	1	15	..	..	1	..	15	..	..	..	..	15	..	..	2
Wisconsin	2	..	5	..	..	..	..	19	..	..	1	..	17	..	..	..	..	4	..	..	5
Minnesota	1	..	2	..	..	1	..	9	..	..	..	..	6	..	..	..	..	2	1	..	..
Kansas	1	..	7	..	..	3	..	13	..	..	2	..	7	..	..	1	..	..	..	..	5
Colorado	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	1	1	..	..
Nebraska	..	..	5	..	..	..	..	6	..	..	..	..	2	..	..	..	..	2	..	..	..
California	1	..	1	..	..	..	..	1	..	..	..	..	1	..	..	..	..	2	..	..	1
Oregon	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	..	1	..
Indian Territory	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Dakota Territory	..	..	1	..	..	..	..	2	..	..	..	..	4	..	..	1	..	2	..	..	1
Montana Territory	1	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Washington Territory	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Idaho Territory	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..
Arizona Territory	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Wyoming Territory	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Delaware	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
West Virginia	..	..	†3	..	..	1	..	8	..	..	1	..	4	..	..	..	..	1	..	..	..
Virginia	..	..	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..
Maryland	..	..	2	..	..	..	..	4	..	..	..	..	2	..	..	..	..	1	..	..	..
North Carolina	..	..	1	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Georgia	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Mississippi	..	..	2	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Louisiana	..	..	2	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	1
Arkansas	..	..	1	..	..	..	..	1	..	..	..	..	2	..	..	..	..	1	..	..	..
Texas	..	..	1	..	..	..	..	2	..	..	..	..	1	..	..	..	..	..	..	..	..
Tennessee	2	..	5	..	..	..	..	6	..	..	..	..	3	..	..	..	..	1	..	..	1
Kentucky	1	..	6	..	..	..	..	5	..	..	2	..	3	..	1	1	..	2	..	..	..
Missouri	3	..	4	..	..	..	..	13	..	..	..	..	10	1	..	1	..	3	1	..	2
Province of Quebec, Canada	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wurtemburg, Germany	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..
Total	75	1	263	1	2	12	3	376	1	1	27	1	299	4	3	9	1	153	10	2	48

Rates amounting to more than $13, marked thus †, is for deafness and other disabilities, or a

State and Territory having deaf pensioners. Compiled from the official pension list of 1893.

RATES.

$10.50	$11.00	$11.25	$12.00	$12.50	$13.75	$13.00	+$14.00	+$14.75	+$15.00	+$16.00	+$17.00	+$18.00	+$18.25	+$18.75	+$20.00	+$24.00	+$25.00	+$30.00	+$37.50	+$50.00	+$62.00	+$72.00	Total deaf.	Partial deaf.	Total number.
...	...	...	1	...	...	1	2	...	1	...	1	2	1	...	...	...	...	...	...	...	...	...	7	38	45
...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	1	17	18
..	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	4	17	21
...	...	...	2	...	1	7	1	...	...	...	1	2	...	...	...	...	...	...	...	...	...	...	13	51	64
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	6
..	...	...	...	...	...	3	...	...	...	...	...	2	...	...	...	...	...	...	...	1	...	...	8	14	22
...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	23	27
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combination of disabilities including deafness; $13 per month a full pension for total deafness.

Capt. Foster also furnished the following summary showing the alleged causes of deafness in seventy soldiers with whom he corresponded on the subject, as follows:

DISABILITY.

28 partially deaf in both ears.
21 totally deaf in one ear and partially in the other.
19 totally deaf in both ears.
2 partially deaf in one ear.

CAUSES.

3 exposure and concussion,
1 measles and typhoid fever.
1 scurvy, exposure, and sunstroke.
2 concussion and injury.
2 exposure and typhoid fever.
3 gunshot wound.
1 typhoid fever and concussion.
15 concussion from artillery.
1 exposure and too much quinine.
15 exposure and catarrh.
2 exposure and mumps.
1 exposure after being wounded.
1 exposure and chronic inflammation of middle ear.
11 exposure, etc.
2 typhoid fever and catarrh.
2 explosion of shell.
2 accident.
1 sunstroke.
1 measles.
2 chills and fever and too much quinine.

PENSIONS.

41 receive no pension.
1 " $1 per month.
3 " $2 " "
2 " $4 " "
3 " $6 " "
3 " $8 " "
2 receive $9 per month.
1 " $10 " "
7 " $13 " "
2 " $17 " "
4 " a pension—amount not stated

BRANCH OF SERVICE.

53 infantry.
5 cavalry.
3 artillery.
3 navy.
5 unknown.

They represent the following States: Ohio, Indiana, Pennsylvania, Iowa, New York, Virginia, Missouri, Illinois, Connecticut, Michigan, Wisconsin, Maryland, Minnesota, New Hampshire, Maine, Colorado, Dakota, Vermont, Oregon, Kentucky, Massachusetts, Kansas, and Nebraska.

The degree of disability caused by total or almost total deafness can roughly be estimated by a comparison with that already agreed upon for injuries, as, for example, the amputation of limbs. It could scarcely be claimed by any one that total deafness was always as great a loss as total blindness. Either defect, however, greatly incapacitates a man for earning his living by ordinary labor; and in this respect he should not be considered the equal of blind or deaf persons who have

been taught in youth (usually at public expense) some occupation specially suited to their needs.

The total or almost total loss of hearing certainly disqualifies a man as much as the loss of a leg above the knee joint. Doubtlessly it is often even a greater loss.

Total deafness in both ears is much more than twice as disqualifying as total deafness in one ear alone. This is a point of very great import to the pension applicant. On the other hand, total loss of hearing in one ear with partial loss of hearing in the other ear is a serious matter, the gravity of which is to be measured by the degree of defectiveness in the better ear. Such deafness being often progressive, the ratio of defectiveness advances with the increasing deafness.

The disability increases very quickly under these circumstances; thus so soon as a person cannot distinguish ordinary voice at five feet, he is greatly incapacitated.

The chief difficulty in adjudicating a case of deafness lies, not so much in estimating the amount of pension allowance, as in ascertaining the cause and degree of disability in each individual case.

Where the hearing organ has suffered impairment either by injury of the drum from concussion of explosives destroying the drum-head or from shot-wounds, the surgeon will generally be able to arrive at a decision without difficulty. Shot-wounds (see page 152) involving the ear are not obscure in their nature, and will be easily recognized. Injury from concussion of great guns and small arms (see pages 194 to 216) is more difficult of recognition, especially after the lapse of many years, and claims should be fortified by evidence of exposure to injury as well as by special examination at the time of application. The writer has found these cases to be quite difficult. The existence of deafness from aural disease due to exposure should be no more difficult of recognition in the hands of the expert than disability from diarrhœa, rheumatism, bronchitis, and the like.

Injury of the inner ear, if long time has elapsed, is difficult of recognition, and a decision must depend very much upon evidence as to the applicant's exposure. It will be found, of course, that in a certain number claiming pensions on account of deafness, the disability is due to influences not specially incident to military service; but that progressive sclerosis of the mucous membrane of the middle ear causing deafness in these cases, is of similar origin to that occurring among persons in all social stations and in every climate. Such deafness is common and should be recognized by pension-examiners. Where aural trouble arises during catarrhal or other fevers, while in

the service, from exposure to hardships or from infectious diseases, as measles, mumps, and the like, it would seem that a pension should be granted for the resulting disability. But where simple progressive sclerosis (results of chronic catarrh?) is the cause of deafness, it will often be difficult, if not impossible, to say whether it began before the soldier's enlistment or not; and in the case of applicants coming up for examination many years after the expiration of the term of service, the relative influence of military life and of subsequent occupation cannot be easily differentiated.

On the other hand, many soldiers came home from the field with partial loss of hearing, and managed to get on very well until their defect increased from some cause; it may have been that one ear only was at first affected; in this way their disability was greatly increased. There is undoubtedly a large class of men, disabled in this manner, worthy of pension.

Soldiers of the War of the Rebellion were not generally given to anticipating aid of this kind during the progress of the war, when most of them were young and strong; but now, after the lapse of twenty-five years, existence in the decline of life requires a more severe struggle, and defects are felt which were never before taken into account; indeed, many have been disinclined to apply for Government aid, though fairly entitled to pensions, so long as they could earn a livelihood.

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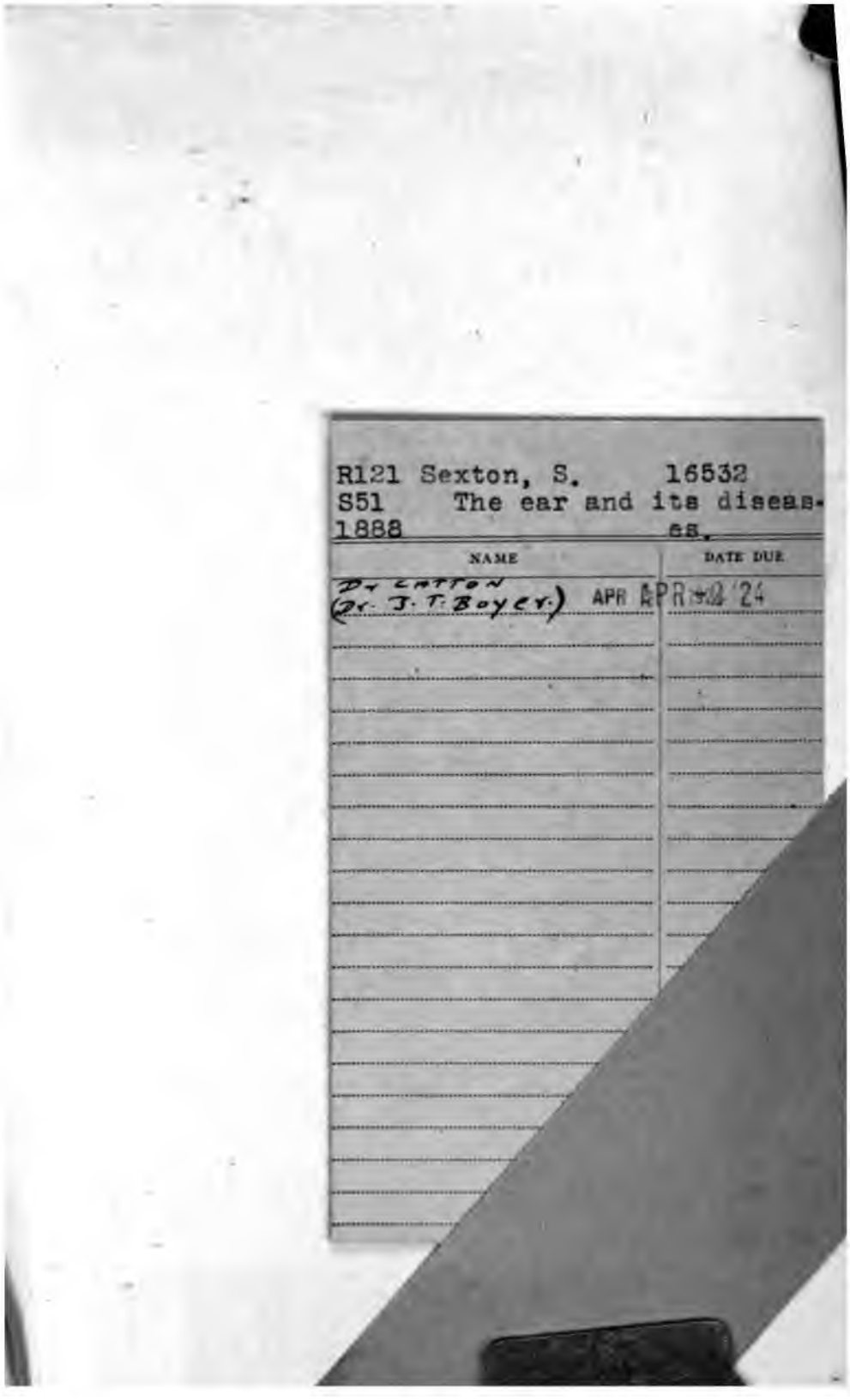
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